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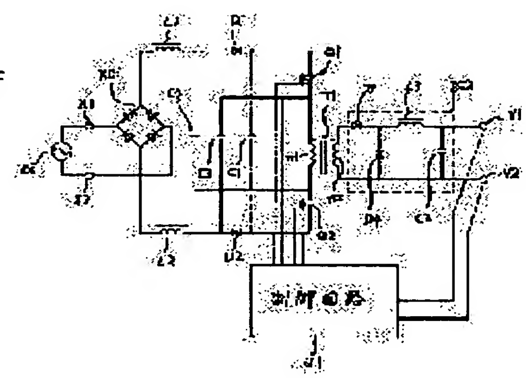
(54) HIGH POWER FACTOR AC/DC CONVERTER

(57)Abstract:
PURPOSE: To get high power factor in a wide load current area, in a small and economical AC/DC converter simple in circuit constitution.
CONSTITUTION: In a converter circuit, which is so arranged as to get specified voltage by rectifying and smoothing AC input voltage, and turning on or turning off this rectified voltage with a switching element, and applying this to the primary winding n1 of a transformer so as to get high frequency AC voltage in secondary winding n2, and rectifying and smoothing this high frequency AC voltage, this is an AC/DC converter where at least two sets of choke coils L1 and L2 for step up and diodes D1 and D2 are interposed between the input rectifying circuit RC1 and the input smoothing capacitor C1, and capacitors C3 and C4 for resonance are connected, respectively, between the junctions between these respective choke coils L1 and L2 for step up and diodes D1 and D2 and the junctions on transformer side of at least two switching elements Q1 and Q2.



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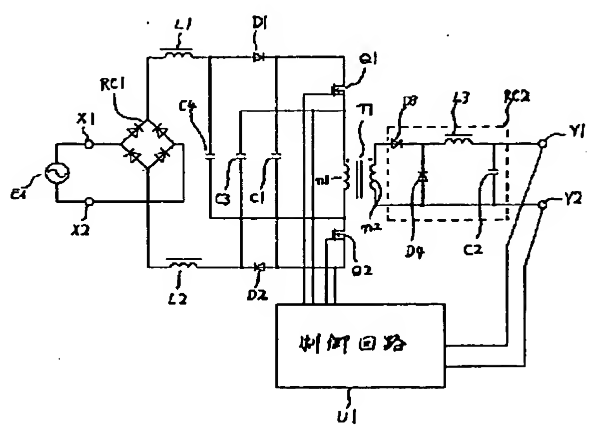
(54)【発明の名称】高力率ＡＣ／ＤＣコンバータ

(57)【要約】

【目的】簡素な回路構成で小型軽量の経済的なＡＣ／ＤＣコンバータにおいて広い負荷電流領域で高力率を得ること。

【構成】交流入力電圧を整流・平滑し、この整流電圧をスイッチング素子によりオン・オフして変圧器の１次巻線に印加し、２次巻線に高周波交流電圧を得て、この高周波交流電圧を整流・平滑して所定の電圧を得るようにしたコンバータ回路において、入力整流回路ＲＣ１と入力平滑用コンデンサＣ１との間に、昇圧用のチョークコイルＬ１，Ｌ２とダイオードＤ１，Ｄ２とを少なくとも２組挿入し、このそれぞれの昇圧用チョークコイルとダイオードとの接続点と少なくとも２つのスイッチング素子Ｑ１，Ｑ２の変圧器側の接続点との間に共振用コンデンサＣ３，Ｃ４をそれぞれ接続したＡＣ／ＤＣコンバータ。



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【特許請求の範囲】

【請求項１】　交流入力電源に接続して交流電圧を整流するブリッジ型の整流回路と、
このブリッジ型の整流回路の直流出力端子に接続される互いに直列接続された少なくとも２つのチョークコイル、少なくとも２つのダイオード、少なくとも１つの平滑用コンデンサと、
前記チョークコイルと前記ダイオードとのそれぞれの接続点にすくなくとも１つの共振用コンデンサを介して一方の主端子が接続され、かつ他方の主端子が前記平滑用コンデンサの一端に接続された少なくとも２つのスイッチング素子と、
前記スイッチング素子間に接続された１次巻線と少なくとも１つの２次巻線とを備えた変圧器と、
前記２次巻線に接続された整流手段と、
前記整流手段の出力電圧を一定に保つために、前記スイッチング素子のオンオフ制御を行う制御回路とからなる高力率ＡＣ／ＤＣコンバータ。

【請求項２】　前記変圧器の２次巻線に接続された整流手段が、前記スイッチング素子のオン時に対応してエネルギーを負荷側へ伝達することを特徴とする請求項１に記載の高力率ＡＣ／ＤＣコンバータ。

【請求項３】　前記変圧器の２次巻線に接続された整流手段が、前記スイッチング素子のオフ時に対応してエネルギーを負荷側へ伝達することを特徴とする請求項１に記載の高力率ＡＣ／ＤＣコンバータ。

【請求項４】　前記変圧器の１次巻線に直列にダイオードが接続されることを特徴とする請求項１乃至請求項３のいずれかに記載の高力率ＡＣ／ＤＣコンバータ。

【請求項５】　前記変圧器の１次巻線に直列に補償インダクタンス手段を設けることを特徴とする請求項１乃至請求項４のいずれかに記載の高力率ＡＣ／ＤＣコンバータ。

【請求項６】　前記補償インダクタンス手段として前記変圧器の漏れインダクタンスを利用して構成することを特徴とする請求項１乃至請求項５のいずれかに記載の高力率ＡＣ／ＤＣコンバータ。

【発明の詳細な説明】

【０００１】

【産業上の利用分野】本発明は、商用交流入力電源電圧を安定な直流出力電圧に変換する高力率のＡＣ／ＤＣコンバータに関する。

【従来技術】商用交流電源を受けて直流電圧を得るＡＣ／ＤＣコンバータ、特に構成の簡単な高力率のＡＣ／ＤＣコンバータとして図８に示すものがある。同図において、Ｅｉは商用の交流入力電源、ＲＣ１は入力端子Ｘ１，Ｘ２に接続された全波整流回路、Ｌ１はチョークコイル、Ｃ３は共振用コンデンサ、Ｄ１はダイオード、Ｃ１は平滑用コンデンサ、Ｑ１はスイッチング素子、Ｔ１は巻数比１：１の１次巻線ｎ１、２次巻線ｎ２を持つ変圧器、Ｄ２は出力整流用ダイオード、Ｄ３はフライ・ホイール・ダイオード、Ｌ２は出力平滑用チョークコイル、Ｃ２は出力平滑用コンデンサ，Ｕ１は出力端子Ｙ１，Ｙ２に接続された制御回路である。ここでスイッチング周波数は商用交流周波数よりも十分に高く、またチョークコイルＬ１のインダクタンスはスイッチング素子Ｑ１のスイッチング周波数に対しては十分に大きく、商用交流の周波数に対しては十分小さな値であって、変圧器Ｔ１の励磁インダクタンスの値よりも十分大きいものとする。

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【０００２】この方式の動作を簡単に説明する。図９に各部の波形を示す。動作が定常状態であって、平滑用コンデンサＣ１の電圧が常に交流入力電源Ｅｉの電圧よりも高く、スイッチング周波数は固定であるものとする。スイッチング素子Ｑ１がオンすると、Ｅｉ→ＲＣ１→Ｌ１→Ｃ３→Ｑ１→ＲＣ１→Ｅｉの経路ができ、スイッチング素子Ｑ１がオンする直前に共振用コンデンサＣ３に残っていたエネルギーと交流入力電源Ｅｉのエネルギーによって、スイッチング素子Ｑ１がオンする直前にチョークコイルＬ１に残っていたエネルギーを増加させる電流が流れる。

【０００３】共振用コンデンサＣ３の電圧が交流入力電源Ｅｉの電圧に達するまでチョークコイルＬ１のエネルギーの増加は続き、共振用コンデンサＣ３の電圧が交流入力電源Ｅｉの電圧を越えると、チョークコイルＬ１のエネルギーは減少を始める。そして共振用コンデンサＣ３の電圧が平滑用コンデンサＣ１の電圧に達すると、チョークコイルＬ１を流れる電流は、Ｃ３→Ｑ１→ＲＣ１→Ｅｉの経路と、Ｄ１→Ｃ１→ＲＣ１→Ｅｉの経路と、Ｄ１→ｎ１→Ｑ１→ＲＣ１→Ｅｉの経路とに分かれて流れ、チョークコイルＬ１のエネルギーは減少を続ける。一方このオン期間中、２次側出力へエネルギーを供給しているのは、共振用コンデンサＣ３の電圧が平滑用コンデンサＣ１の電圧に達するまでは平滑用コンデンサＣ１であり、共振用コンデンサＣ３の電圧が平滑用コンデンサＣ１の電圧に達した後は、チョークコイルＬ１と平滑用コンデンサＣ１との両方である。この時点で平滑用コンデンサＣ１の電圧が上昇するか下降するかは、このときの負荷電流と入力電流の大きさに依存する。このオン期間中に変圧器Ｔ１には励磁エネルギーが蓄えられる。

【０００４】つぎにスイッチング素子Ｑ１をオフすると、チョークコイルＬ１に流れる電流はＤ１→Ｃ１→ＲＣ１→Ｅｉの経路を流れ、平滑用コンデンサＣ１を充電する。そして、チョークコイルＬ１のエネルギーは減少を続ける。また共振用コンデンサＣ３に蓄えられたエネルギーは、Ｃ３→Ｄ１→ｎ１→Ｃ３の経路で放電され、フライ・ホイル・ダイオードＤ３が導通するまでエネルギーを２次側出力へ供給し続ける。このとき、スイッチング素子Ｑ１に印加される電圧は共振用コンデンサＣ３のエネルギーが放出されるのに伴い徐々に上昇し、共振

用コンデンサＣ３の電圧がゼロになった時点で平滑用コンデンサＣ１の電圧に達する。共振用コンデンサＣ３の電圧がゼロになると、変圧器Ｔ１の励磁エネルギーの放出が始まり、共振用コンデンサＣ３の電圧はそれまでとは逆向きに上昇をはじめ、共振用コンデンサＣ３と変圧器Ｔ１の励磁インダクタンスとの自由振動、つまり共振が始まり、出力整流ダイオードＤ２は逆バイアス状態に変わる。このとき、スイッチング素子Ｑ１に印加される電圧は平滑用コンデンサＣ１の電圧に変圧器Ｔ１のリセット電圧を加えた値となる。

【０００５】変圧器Ｔ１の励磁エネルギーの放出が終了し、共振用コンデンサＣ３の電圧がピークになると、共振用コンデンサＣ３からのエネルギーの放出が始まり、１次巻線ｎ１に流れていた電流の向きが逆に増加していく。１次巻線ｎ１に流れる電流がチョークコイルＬ１に流れている電流と等しくなるまで上昇すると、ダイオードＤ１がオフし、チョークコイルＬ１を流れていた電流は、Ｃ３→ｎ１→Ｃ１→ＲＣ１→Ｅｉの経路に流れ、共振用コンデンサＣ３の持つエネルギーとチョークコイルＬ１の持つエネルギーとで平滑用コンデンサＣ１の充電を始める。チョークコイルＬ１のインダクタンスは変圧器Ｔ１の励磁インダクタンスに比べ十分に大きな値をもつので、１次巻線ｎ１に流れる電流の変化量が小さくなり発生する電圧も急速に減少する。このとき、チョークコイルＬ１と１次巻線ｎ１には交流入力電源Ｅｉの電圧、共振用コンデンサＣ３の電圧、平滑用コンデンサＣ１の電圧の合計が印加され、チョークコイルＬ１のエネルギーは再び増加を始める。１次巻線ｎ１に発生していた電圧がゼロまで減少し、極性が反転しようとすると出力平滑用チョークコイルＬ２の電流が出力整流ダイオードＤ２とフライ・ホイル・ダイオードＤ３とに分流するため、２次巻線ｎ２は等価的に短絡されたことになり、１次巻線ｎ１の電圧はゼロに抑えられ、励磁電流の変化がなくなり、チョークコイルＬ１と共振用コンデンサＣ３、平滑用コンデンサＣ１との自由振動による電流変化分が出力平滑用チョークコイルＬ２の電流の分流として、変圧器Ｔ１の各巻線に流れる。このとき、スイッチング素子Ｑ１に印加される電圧は平滑用コンデンサＣ１の電圧に抑えられる。

【０００６】以上の動作を繰り返してエネルギーの伝達を行う。そして、交流入力電源Ｅｉの電圧のゼロ付近ではスイッチング素子Ｑ１のオフ期間中に放電し終わらなかった共振用コンデンサＣ３のエネルギーが大きく、スイッチング素子Ｑ１のオン期間中にチョークコイルＬ１に蓄積するエネルギーを相対的に大きくしているが、交流入力電源Ｅｉと平滑用コンデンサＣ１との電圧差も大きいので、放出するエネルギーも大きくなる。一方、交流入力電源Ｅｉの電圧のピーク付近では、スイッチング素子Ｑ１のオフ期間中に放電し終わらなかった共振用コンデンサＣ３のエネルギーは少なく、スイッチング素子Ｑ１のオン期間中にチョークコイルＬ１に蓄積するエネルギーを相対的に小さくしているが、交流入力電源Ｅｉと平滑用コンデンサＣ１との電圧差も小さいので，チョークコイルＬ１が放出するエネルギーも小さくなる。このことから、スイッチング周波数成分を取り除くフィルタを交流入力電源Ｅｉと全波整流回路ＲＣ１の間に設ければ、図１０に示すような入力電流が得られ、従来のものに比べ力率は改善される。

【０００７】しかし、定常状態で動作しているとき、変圧器Ｔ１の励磁エネルギーとチョークコイルＬ１、交流入力電源Ｅｉから供給される平滑用コンデンサＣ１の充電エネルギーは、交流入力電源Ｅｉの電圧に多少影響されるものの、負荷電流にほとんど影響されないため、図４の直線ａで示すように負荷電流I_oが増大するのに伴い平滑用コンデンサＣ１の電圧は大きな傾斜で降下し，交流入力電源Ｅｉの電圧の最大値E_{imax}に対応する負荷電流の最大値I_aは小さな値となってしまう。したがって，負荷電流は狭い範囲に制限されてしまい，また軽負荷時に充電エネルギーが過剰になり、平滑用コンデンサＣ１の電圧が大きく上昇してしまう。そのため、スイッチング素子Ｑ１や平滑用コンデンサＣ１に高耐圧の部品を使用するか、又は負荷電流範囲を狭めた設計をしなければならない。狭めた設計をした負荷電流範囲を越えて負荷電流をとるとコンバータとしての動作はするが図１１に示すような入力電流波形になり、力率は低下する。これは，負荷電流が増加するのに伴い平滑用コンデンサＣ１の電圧が低下して交流入力電源Ｅｉの電圧の最大値E_{imax}より減少すると、交流入力電源Ｅｉの電圧が平滑用コンデンサＣ１の電圧を越える区間ができ、スイッチング素子Ｑ１のオンオフと無関係に電流が平滑用コンデンサＣ１に流れ込むためである。

【０００８】

【発明が解決しようとする課題】本発明は、簡素な回路構成で、小型軽量、経済的な高力率ＡＣ／ＤＣコンバータ回路を得ることを課題とする。

【課題を解決するための手段】本発明はこの課題を解決するために、交流入力電圧を整流・平滑し、この整流電圧を半導体スイッチング素子によりオン・オフして変圧器の１次巻線に印加し、２次巻線に高周波交流電圧を得て、この高周波交流電圧を整流・平滑して所定の電圧を得るようにしたコンバータ回路において、入力整流回路と入力平滑用コンデンサとの間に、昇圧用チョークコイルとダイオードとを少なくとも２つずつ挿入し、このそれぞれの昇圧用チョークコイルとダイオードとの接続点と少なくとも２つのスイッチング素子の変圧器側の接続点との間に共振用コンデンサをそれぞれ接続したことを特徴とする高力率ＡＣ／ＤＣコンバータを提案するものである。

【０００９】

【実施例】この発明の基本的な部分は、スイッチング素

子を複数にし、スイッチング素子に印加される電圧を分散することで、軽負荷時の平滑用コンデンサＣ１の電圧上昇分を補い、負荷電流と平滑用コンデンサＣ１の電圧との関係を図４に示す直線ａから直線ｂに改善し、これによって、広い負荷電流の範囲にわたって高力率を維持することを主な特徴とする。図１により、本発明に係わる高力率ＡＣ／ＤＣコンバータを説明する。図１において、Ｅｉは商用の交流入力電源、Ｘ１，Ｘ２は入力端子、ＲＣ１は全波整流回路、Ｌ１、Ｌ２は昇圧用のチョークコイル、Ｄ１、Ｄ２はダイオード、Ｃ１は平滑用コンデンサ、Ｃ３、Ｃ４は共振用コンデンサ、Ｔ１は巻数比１：１の１次巻線ｎ１、２次巻線ｎ２を持つ変圧器である。また、Ｄ３は出力整流用ダイオード、Ｄ４はフライ・ホイール・ダイオード、Ｌ３は出力平滑用チョークコイル、Ｃ２は出力平滑用コンデンサであり、これらは出力側整流・平滑回路ＲＣ２を構成する。スイッチング素子Ｑ１、Ｑ２はＦＥＴのようなスイッチング半導体素子からなり、制御回路Ｕ１はスイッチング素子Ｑ１、Ｑ２を商用交流周波数よりも十分に高い周波数でオン・オフ駆動する。

【００１０】ここで、チョークコイルＬ１、Ｌ２のインダクタンスはスイッチング素子Ｑ１、Ｑ２のスイッチング周波数に対しては十分に大きな値となり、商用交流の周波数に対しては十分小さな値で、Ｔ１の励磁インダクタンスの値よりも十分大きいものとする。動作は定常状態であって、平滑用コンデンサＣ１の電圧が常に交流入力電源Ｅｉの電圧よりも高く、スイッチング周波数は固定であるものとする。このときの各部の電流，電圧波形を図２に示す。スイッチング素子Ｑ１、Ｑ２がオンすると、Ｅｉ→ＲＣ１→Ｌ１→Ｃ４→Ｑ２→Ｃ１→Ｑ１→Ｃ３→Ｌ２→ＲＣ１→Ｅｉの経路ができ、スイッチング素子Ｑ１、Ｑ２がオンする直前に共振用コンデンサＣ３、Ｃ４に残っていたエネルギーと平滑用コンデンサＣ１のエネルギーと交流入力電源Ｅｉのエネルギーによって、スイッチング素子Ｑ１、Ｑ２がオンする直前にチョークコイルＬ１、Ｌ２に残っていたエネルギーを増加させる電流が流れる。

【００１１】共振用コンデンサＣ３、Ｃ４の電圧の和が、平滑用コンデンサＣ１の電圧と交流入力電源Ｅｉの電圧の和に達するまでチョークコイルＬ１、Ｌ２のエネルギーの増加は続き、この電圧を越えると、チョークコイルＬ１、Ｌ２のエネルギーは減少を始める。共振用コンデンサＣ３、Ｃ４それぞれの電圧が平滑用コンデンサＣ１の電圧に達すると、ダイオードＤ１、Ｄ２が導通し、チョークコイルＬ１、Ｌ２を流れる電流は、Ｌ１→Ｃ４→Ｑ２→Ｄ２→Ｌ２→ＲＣ１→Ｅｉの経路と、Ｌ１→Ｄ１→Ｃ１→Ｄ２→Ｌ２→ＲＣ１→Ｅｉの経路と、Ｌ１→Ｄ１→Ｑ１→Ｃ３→Ｌ２→ＲＣ１→Ｅｉの経路と、Ｌ１→Ｄ１→Ｑ１→ｎ１→Ｑ２→Ｄ２→Ｌ２→ＲＣ１→Ｅｉの経路とに分かれて流れチョークコイルＬ１，Ｌ２

のエネルギーは減少を続ける。

【００１２】一方このオン期間中、２次側出力へエネルギーを供給しているのは、共振用コンデンサＣ３、Ｃ４の電圧の和が平滑用コンデンサＣ１と交流入力電源Ｅｉの電圧の和に達するまでは平滑用コンデンサＣ１であり、その電圧に達してからは、チョークコイルＬ１、Ｌ２とＣ１との両方である。この時点で平滑用コンデンサＣ１の電圧が上昇するか下降するかは、このときの負荷電流と入力電流の大きさに依存する。このオン期間中にＴ１には励磁エネルギーが蓄えられる。つぎにスイッチング素子Ｑ１、Ｑ２をオフすると、チョークコイルＬ１、Ｌ２に流れる電流はＬ１→Ｄ１→Ｃ１→Ｄ２→Ｌ２→ＲＣ１→Ｅｉの経路を流れ、平滑用コンデンサＣ１を充電する。そして、チョークコイルＬ１、Ｌ２のエネルギーは減少を続ける。また共振用コンデンサＣ３、Ｃ４に蓄えられたエネルギーは、Ｃ３→ｎ１→Ｃ４→Ｄ１→Ｃ１→Ｄ２→Ｃ３の経路で放電され、共振用コンデンサＣ３、Ｃ４の電圧の和が平滑用コンデンサＣ１の電圧まで低下するまで、エネルギーを２次側出力へ供給し続ける。このとき、スイッチング素子Ｑ１、Ｑ２のそれぞれに印加される電圧は、共振用コンデンサＣ３、Ｃ４のエネルギーが放出されるのにともない徐々に上昇し、共振用コンデンサＣ３、Ｃ４の電圧の和が平滑用コンデンサＣ１の電圧に達した時点で平滑用コンデンサＣ１の電圧の１／２の電圧に達する。

【００１３】共振用コンデンサＣ３、Ｃ４の電圧の和が平滑用コンデンサＣ１の電圧に達すると、変圧器Ｔ１の１次巻線ｎ１の電圧はゼロまで下がり、２次側出力へのエネルギーの供給は止まる。この時点から変圧器Ｔ１の励磁エネルギーの放出が始まる。変圧器Ｔ１の励磁エネルギーの放出は、ｎ１→Ｃ４→Ｄ１→Ｃ１→Ｄ２→Ｃ３→ｎ１の経路の自由振動として行われ、共振用コンデンサＣ３、Ｃ４に残っているエネルギーと変圧器Ｔ１の励磁エネルギーとによって、平滑用コンデンサＣ１を充電する。共振用コンデンサＣ３、Ｃ４の電圧がゼロに達した後は、残った変圧器Ｔ１の励磁エネルギーによって、共振用コンデンサＣ３、Ｃ４と平滑用コンデンサＣ１を充電する。このとき、スイッチング素子Ｑ１、Ｑ２それぞれに印加される電圧は、平滑用コンデンサＣ１の電圧に共振用コンデンサＣ３、Ｃ４の電圧を加えた値の１／２になり，スイッチング素子Ｑ１、Ｑ２が平滑用コンデンサＣ１の電圧をほぼ等しく１／２づつ分担する。

【００１４】変圧器Ｔ１の励磁エネルギーの放出が終了し、共振用コンデンサＣ３、Ｃ４の電圧がピークになると、共振用コンデンサＣ３、Ｃ４からのエネルギー放出が始まり、１次巻線ｎ１に流れていた電流の向きが逆向きに増加し、１次巻線ｎ１に発生していた電圧は低下を始める。１次巻線ｎ１に流れる電流がチョークコイルＬ１、Ｌ２に流れている電流と等しくなるまで上昇すると、ダイオードＤ１、Ｄ２がオフし、チョークコイルＬ

1、L2を流れていた電流は、L1→C4→n1→C3→L2→RC1→Eiの経路に流れる。チョークコイルL1、L2のインダクタンスは変圧器T1の励磁インダクタンスに比べ十分大きな値なので、1次巻線n1を流れる電流の変化量が非常に小さく、したがって1次巻線n1に発生する電圧は急速に減少し、ほぼゼロになる。1次巻線n1に発生していた電圧がゼロまで減少すると、出力平滑用チョークコイルL3の電流が出力整流ダイオードD3とフライ・ホイール・ダイオードD4に分流し、チョークコイルL1、L2と共振用コンデンサC3、C4との自由振動による電流変化分が出力平滑用チョークコイルL3の電流の分流として、変圧器T1の各巻線に流れる。このとき、スイッチング素子Q1、Q2それぞれに印加される電圧は平滑用コンデンサC1の電圧の1／2に抑えられる。

【0015】この状態で、チョークコイルL1、L2には共振用コンデンサC3、C4の電圧と交流入力電源Eiの電圧が印加され、チョークコイルL1、L2のエネルギーを増加させる始める。以上の動作を繰り返してエネルギーの伝達を行う。そして、交流入力電源Eiの電圧のゼロ付近ではスイッチング素子Q1、Q2のオフ期間中に放電し終わらなかった共振用コンデンサC3、C4のエネルギーが大きく、スイッチング素子Q1、Q2のオン期間中にチョークコイルL1、L2に蓄積するエネルギーを相対的に大きくしているが、交流入力電源Eiと平滑用コンデンサC1との電圧差も大きいので、放出するエネルギーも大きくなる。一方、交流入力電源Eiの電圧のピーク付近では、スイッチング素子Q1、Q2のオフ期間中に放電し終わらなかった共振用コンデンサC3、C4のエネルギーは少なく、スイッチング素子Q1、Q2のオン期間中にチョークコイルL1、L2に蓄積するエネルギーを相対的に小さくしているが、交流入力電源Eiと平滑用コンデンサC1との電圧差も小さいので放出するエネルギーも小さくなる。このことから、チョークコイルL1、L2に流れる電流は、図3に示すような歪みの極めて小さい入力電流になり、力率は改善される。さらに、スイッチング素子を2つにしたことにより、各スイッチング素子に印加される電圧が低減されているので、平滑用コンデンサC1の電圧を、従来よりも高く設定することができ、高力率で動作する負荷範囲を広く設定できる。

【0016】〔第2の実施例〕次に図5により本発明の第2の実施例を説明する。この実施例は図1に示した実施例と同様の構成であるが、構成上の相違点としては、変圧器T1の接続極性が図1の場合と異なり、逆極性になる点、および出力側整流・平滑回路RC2が出力整流ダイオードD3と出力平滑コンデンサC2のみからなる半波整流回路である点である。そして、この構成上の相違点による動作の違いとしては、コンバータ動作がいわゆるフォワード型からフライバック型に置き換えられるところにある。それ以外の本発明の目的とする高力率を得る点、高力率で動作する負荷電流範囲を広く設定できる点については共通である。重複を避けながら以下に説明を行う。スイッチング素子Q1、Q2がオンの期間では、1次側の電流が前記第1の実施例と同様な経路で流れるので説明を省略する。このオン期間中に、ダイオードD3は逆バイアス状態にあってオフしており、2次側には電流は流れない。したがって、1次巻線n1には平滑用コンデンサC1の電圧で電流が流れ、励磁エネルギーを蓄える。共振用コンデンサC3、C4の電圧の和が平滑用コンデンサC1の電圧と交流入力電源Eiの電圧の和に達するまでは、平滑用コンデンサC1の電圧で励磁エネルギーを蓄え、その電圧に達した後は、チョークコイルL1、L2と平滑用コンデンサC1とから励磁エネルギーが供給される。このオン期間は負荷の状態によって、増減するので励磁エネルギーもこれに比例する。

【0017】つぎにスイッチング素子Q1、Q2をオフすると、チョークコイルL1、L2に流れる電流はL1→D1→C1→D2→L2→RC1→Eiの経路を流れ、平滑用コンデンサC1を充電する。そして、チョークコイルL1、L2のエネルギーは減少を続ける。また共振用コンデンサC3、C4に蓄えられたエネルギーは、C3→n1→C4→D1→C1→D2→C3の経路で放電され、共振用コンデンサC3、C4の電圧の和が、平滑用コンデンサC1の電圧まで低下するまで、変圧器T1の励磁エネルギーを増加させる。このとき、スイッチング素子Q1、Q2のそれぞれに印加される電圧は、共振用コンデンサC3、C4のエネルギーが放出されるのにともない徐々に上昇し、共振用コンデンサC3、C4の電圧の和が平滑用コンデンサC1の電圧に達した時点で平滑用コンデンサC1の電圧の1／2の電圧に達する。共振用コンデンサC3、C4の電圧の和が平滑用コンデンサC1の電圧に達すると、変圧器T1の1次巻線n1の電圧はゼロまで下がり、この時点から変圧器T1の励磁エネルギーの放出が始まる。変圧器T1の励磁エネルギーの放出は、n1→C4→D1→C1→D2→C3→n1の経路の自由振動として始まり、共振用コンデンサC3、C4に残っているエネルギーと変圧器T1の励磁エネルギーとによって、平滑用コンデンサC1を充電する。

【0018】1次巻線n1の電圧が出力平滑用コンデンサC2の電圧に達すると、出力整流ダイオードD3が導通し、変圧器T1の励磁エネルギーが出力へのエネルギー供給を始める。そして、1次巻線n1の電圧は、出力平滑用コンデンサC2の電圧にクランプされ、共振用コンデンサC3、C4と平滑用コンデンサC1と変圧器T1の励磁インダクタンスとの自由振動は、変圧器T1に残っていた励磁エネルギーがすべて2次側へ供給され、1次巻線n1のクランプが解放されるまで続く。このとき、スイッチング素子Q1、Q2それぞれに印加される

電圧は平滑用コンデンサＣ１の電圧に共振用コンデンサＣ３、Ｃ４の電圧を加えた値の１／２になる。変圧器Ｔ１の励磁エネルギーの放出が終わり、共振用コンデンサＣ３、Ｃ４からのエネルギー放出が始まると、Ｃ４→ｎ１→Ｃ３→Ｄ２→Ｃ１→Ｄ１→Ｄ４の経路で電流が増加し、１次巻線ｎ１に流れる電流がチョークコイルＬ１、Ｌ２に流れている電流と等しくなるまで上昇すると、ダイオードＤ１、Ｄ２がオフし、チョークコイルＬ１、Ｌ２を流れていた電流は、Ｌ１→Ｃ４→ｎ１→Ｃ３→Ｌ２→ＲＣ１→Ｅｉの経路に流れる。チョークコイルＬ１、Ｌ２のインダクタンスは変圧器Ｔ１の励磁インダクタンスに比べ十分大きな値なので、１次巻線ｎ１を流れる電流の変化量が非常に小さく、１次巻線ｎ１に発生する電圧は急速に減少し、ほぼゼロになる。このとき、スイッチング素子Ｑ１、Ｑ２それぞれに印加される電圧は平滑用コンデンサＣ１の電圧の１／２に抑えられる。

【００１９】この状態で、チョークコイルＬ１、Ｌ２には共振用コンデンサＣ３、Ｃ４の電圧と交流入力電源Ｅｉの電圧が印加され、チョークコイルＬ１、Ｌ２のエネルギーを増加させ始める。以上の動作を繰り返してエネルギーの伝達を行う。この実施例の効果は前記第１の実施例と全く同様なので説明を省略する。なお、この実施例において、各スイッチング素子と直列にダイオードを設けても同じ効果が得られる。

【００２０】〔第３の実施例〕次に図６により発明の第３の実施例を説明する。この実施例は図１に示した実施例と同様の構成であるが、構成上の相違点としては、変圧器Ｔ１の１次巻線ｎ１と直列に，補償用インダクタンス手段として補償用インダクタＬ４を設けた点である。そして、この構成上の相違点による動作の違いとしては、スイッチング素子Ｑ１、Ｑ２のオン期間中に負荷電流に比例した励磁エネルギーを補償用インダクタンスＬ４に蓄え、そのエネルギーをオフ期間中に共振用コンデンサＣ３，Ｃ４で中継して平滑用コンデンサＣ１に供給する点である。それ以外の本発明の目的とする高力率を得る点、高力率で動作する負荷電流範囲を広く設定できる点については共通であり、この実施例では、軽負荷時の平滑用コンデンサＣ１の電圧上昇分を補い、負荷電流と平滑用コンデンサＣ１の電圧との関係を図４に示す直線ａから直線ｃに改善し、これによって、より広い負荷電流の範囲にわたって高力率を維持することを主な特徴とする。重複を避けながら説明を行う。

【００２１】スイッチング素子Ｑ１、Ｑ２がオンすると、Ｅｉ→ＲＣ１→Ｌ１→Ｃ４→Ｑ２→Ｃ１→Ｑ１→Ｃ３→Ｌ２→ＲＣ１→Ｅｉの経路ができ、スイッチング素子Ｑ１、Ｑ２がオンする直前に共振用コンデンサＣ３、Ｃ４に残っていたエネルギーと平滑用コンデンサＣ１のエネルギーと交流入力電源Ｅｉのエネルギーによって、スイッチング素子Ｑ１、Ｑ２がオンする直前にチョークコイルＬ１、Ｌ２に残っていたエネルギーを増加させる電流が流れる。共振用コンデンサＣ３、Ｃ４の電圧の和が、平滑用コンデンサＣ１の電圧と交流入力電源Ｅｉの電圧の和に達するまでチョークコイルＬ１、Ｌ２のエネルギーの増加は続き、この電圧を越えると、チョークコイルＬ１、Ｌ２のエネルギーは減少を始める。

【００２２】共振用コンデンサＣ３、Ｃ４それぞれの電圧が平滑用コンデンサＣ１の電圧に達すると、ダイオードＤ１、Ｄ２が導通し、チョークコイルＬ１、Ｌ２を流れる電流は、Ｌ１→Ｃ４→Ｑ２→Ｄ２→Ｌ２→ＲＣ１→Ｅｉの経路と、Ｌ１→Ｄ１→Ｃ１→Ｄ２→Ｌ２→ＲＣ１→Ｅｉの経路と、Ｌ１→Ｄ１→Ｑ１→Ｃ３→Ｌ２→ＲＣ１→Ｅｉの経路と、Ｌ１→Ｄ１→Ｑ１→Ｌ４→ｎ１→Ｑ２→Ｄ２→Ｌ２→ＲＣ１→Ｅｉの経路とに分かれて流れチョークコイルＬ１、Ｌ２のエネルギーは減少を続ける。一方このオン期間中、２次側出力へエネルギーを供給しているのは、共振用コンデンサＣ３、Ｃ４の電圧の和が平滑用コンデンサＣ１と交流入力電源Ｅｉの電圧の和に達するまでは、平滑用コンデンサＣ１であり、その電圧に達してからは、チョークコイルＬ１、Ｌ２と平滑用コンデンサＣ１との両方である。この時点で平滑用コンデンサＣ１の電圧が上昇するか下降するかは、このときの負荷電流と入力電流の大きさに依存する。このオン期間中に変圧器Ｔ１には励磁エネルギーが蓄えられ、補償用インダクタンスＬ４には負荷電流に比例したエネルギーが蓄えられる。

【００２３】つぎにスイッチング素子Ｑ１、Ｑ２をオフすると、チョークコイルＬ１、Ｌ２に流れる電流はＬ１→Ｄ１→Ｃ１→Ｄ２→Ｌ２→ＲＣ１→Ｅｉの経路を流れ、平滑用コンデンサＣ１を充電する。そして、チョークコイルＬ１、Ｌ２のエネルギーは減少を続ける。また共振用コンデンサＣ３、Ｃ４に蓄えられたエネルギーは、Ｃ３→Ｌ４→ｎ１→Ｃ４→Ｄ１→Ｃ１→Ｄ２→Ｃ３の経路で放電され、共振用コンデンサＣ３、Ｃ４の電圧の和が、平滑用コンデンサＣ１の電圧まで低下するまで、エネルギーを２次側出力へ供給し続け、補償用インダクタンスＬ４にエネルギーを蓄える。このとき、スイッチング素子Ｑ１、Ｑ２のそれぞれに印加される電圧は、共振用コンデンサＣ３、Ｃ４のエネルギーが放出されるのにともない徐々に上昇し、共振用コンデンサＣ３、Ｃ４の電圧の和が平滑用コンデンサＣ１の電圧に達した時点で平滑用コンデンサＣ１の電圧の１／２の電圧に達する。

【００２４】共振用コンデンサＣ３、Ｃ４の電圧の和が平滑用コンデンサＣ１の電圧に達すると、変圧器Ｔ１の１次巻線ｎ１と補償用インダクタンスＬ４の電圧はゼロまで下がり、２次側出力へのエネルギーの供給は止まる。この時点で，フライ・ホイール・ダイオードＤ４の逆バイアス状態が維持できなくなり，出力平滑チョークコイルＬ３の電流が出力整流用ダイオードＤ３とフライ・ホイール・ダイオードＤ４とに分流し、変圧器Ｔ１の

２次巻線ｎ２を等価的に短絡し、１次巻線ｎ１の電圧はゼロになり、補償用インダクタンスＬ４のエネルギーの放出によって、共振コンデンサＣ３、Ｃ４と平滑用コンデンサＣ１と補償用インダクタンスＬ４との間で自由振動を始め、共振用コンデンサＣ３、Ｃ４のエネルギーと補償用インダクタンスＬ４のエネルギーとで平滑用コンデンサＣ１を充電する。補償用インダクタンスＬ４の電流が変圧器Ｔ１の励磁電流の大きさまで減少すると、変圧器Ｔ１の励磁エネルギーの放出が始まり，共振用コンデンサＣ３、Ｃ４に残っているエネルギーと変圧器Ｔ１の励磁エネルギーとによって、平滑用コンデンサＣ１を充電する。共振用コンデンサＣ３、Ｃ４の電圧がゼロに達した後は、残った変圧器Ｔ１の励磁エネルギーによって、共振用コンデンサＣ３、Ｃ４と平滑用コンデンサＣ１を充電する。このとき、スイッチング素子Ｑ１、Ｑ２それぞれに印加される電圧は平滑用コンデンサＣ１の電圧に共振用コンデンサＣ３、Ｃ４の電圧を加えた値の１／２になる。

【００２５】変圧器Ｔ１の励磁エネルギーの放出が終了し、共振用コンデンサＣ３、Ｃ４の電圧がピークになると、共振用コンデンサＣ３、Ｃ４からのエネルギー放出が始まり、１次巻線ｎ１に流れていた電流の向きが逆向きに増加し、補償用インダクタンスＬ４と１次巻線ｎ１に発生していた電圧は低下を始める、１次巻線ｎ１に流れる電流がチョークコイルＬ１、Ｌ２に流れている電流と等しくなるまで上昇すると、ダイオードＤ１、Ｄ２がオフし、チョークコイルＬ１、Ｌ２を流れていた電流は、Ｌ１→Ｃ４→ｎ１→Ｌ４→Ｃ３→Ｌ２→ＲＣ１→Ｅｉの経路に流れる。チョークコイルＬ１、Ｌ２のインダクタンスは補償用インダクタンスＬ４と変圧器Ｔ１の励磁インダクタンスに比べ十分大きな値なので、流れる電流の変化量が非常に小さく、補償用インダクタンスＬ４と１次巻線ｎ１に発生する電圧は急速に減少し、ほぼゼロになる。１次巻線ｎ１に発生していた電圧がゼロまで減少すると，出力整流ダイオードＤ３の逆バイアスが維持できなくなり，出力平滑用チョークコイルＬ３の電流が出力整流ダイオードＤ３とフライ・ホイール・ダイオードＤ４に分流し、チョークコイルＬ１、Ｌ２と共振用コンデンサＣ３、Ｃ４との自由振動による電流変化分が出力平滑用チョークコイルＬ３の電流の分流として、変圧器Ｔ１の各巻線に流れる。このとき、スイッチング素子Ｑ１、Ｑ２それぞれに印加される電圧は平滑用コンデンサＣ１の電圧の１／２に抑えられる。

【００２６】この状態で、チョークコイルＬ１、Ｌ２には共振用コンデンサＣ３、Ｃ４の電圧と交流入力電源Ｅｉの電圧が印加され、チョークコイルＬ１、Ｌ２のエネルギーを増加させる始める。以上の動作を繰り返してエネルギーの伝達を行う。補償用インダクタンスＬ４を設けたことにより、負荷電流に応じたエネルギーを平滑用コンデンサＣ１に供給するエネルギーに付加できるので、軽負荷時に過大な電圧が平滑用コンデンサＣ１に発生するのを防止し、高力率で動作する負荷電流の範囲をより広く設定できる。この他の効果は前記第１の実施例とほぼ同様なので説明を省略する。

【００２７】〔第４の実施例〕次に図７により発明の第４の実施例を説明する。この実施例は図１に示した実施例と同様の構成であるが、構成上の相違点としては、変圧器Ｔ１の１次巻線ｎ１と直列に補償用インダクタンスＬ４を設けてある点、変圧器Ｔ１の接続極性が図１の場合と異なり、逆極性になる点、および出力側整流・平滑回路ＲＣ２が出力整流ダイオードＤ３と出力平滑コンデンサＣ２のみからなる半波整流回路である点である。そして、この構成上の相違点による動作の違いとしては、スイッチング素子Ｑ１、Ｑ２のオン期間中に負荷電流に比例した励磁エネルギーを補償インダクタンスＬ４に蓄え、そのエネルギーをオフ期間中に共振用コンデンサＣ３，Ｃ４で中継して平滑用コンデンサＣ１に供給する点、コンバータ動作がいわゆるフォワード型からフライバック型に置き換えられている点である。それ以外の本発明の目的とする高力率を得る点、高力率で動作する負荷電流範囲を広く設定できる点については共通である。重複を避けながら説明をする。

【００２８】スイッチング素子Ｑ１、Ｑ２がオンの期間では、１次側の電流が前記第３の実施例と同様な経路で流れるので説明を省略する。このオン期間中に、ダイオードＤ３は逆バイアス状態にありオフしており、２次側には電流は流れない。したがって、補償用インダクタンスＬ４と巻線ｎ１には平滑用コンデンサＣ１の電圧で電流が流れ、励磁エネルギーを蓄える。共振用コンデンサＣ３、Ｃ４の電圧の和が平滑用コンデンサＣ１の電圧と交流入力電源Ｅｉの電圧の和に達するまでは、平滑用コンデンサＣ１の電圧で励磁エネルギーを蓄え、その電圧を越えた後は、チョークコイルＬ１、Ｌ２と平滑用コンデンサＣ１とから励磁エネルギーが供給される。つぎにスイッチング素子Ｑ１、Ｑ２をオフすると、チョークコイルＬ１、Ｌ２に流れる電流はＬ１→Ｄ１→Ｃ１→Ｄ２→Ｌ２→ＲＣ１→Ｅｉの経路を流れ、平滑用コンデンサＣ１を充電する。そして、チョークコイルＬ１、Ｌ２のエネルギーは減少を続ける。また共振用コンデンサＣ３、Ｃ４に蓄えられたエネルギーは、Ｃ３→Ｌ４→ｎ１→Ｃ４→Ｄ１→Ｃ１→Ｄ２→Ｃ３の経路で放電され、共振用コンデンサＣ３、Ｃ４の電圧の和が、平滑用コンデンサＣ１の電圧まで低下するまで、補償用インダクタンスＬ４と変圧器Ｔ１の励磁エネルギーを増加させる。このとき、スイッチング素子Ｑ１、Ｑ２のそれぞれに印加される電圧は、共振用コンデンサＣ３、Ｃ４のエネルギーが放出されるのにともない徐々に上昇し、共振用コンデンサＣ３、Ｃ４の電圧の和が平滑用コンデンサＣ１の電圧に達した時点で平滑用コンデンサＣ１の電圧の１／２の電圧に達する。

【００２９】共振用コンデンサＣ３、Ｃ４の電圧の和が平滑用コンデンサＣ１の電圧に達すると、補償用インダクタンスＬ４と変圧器Ｔ１の１次巻線ｎ１の電圧はゼロまで下がり、この時点から励磁エネルギーの放出が始まる。補償用インダクタンスＬ４と変圧器Ｔ１の励磁エネルギーの放出は、ｎ１→Ｃ４→Ｄ１→Ｃ１→Ｄ２→Ｃ３→ｎ１の経路の自由振動として始まり、共振用コンデンサＣ３、Ｃ４に残っているエネルギーと変圧器Ｔ１の励磁エネルギーとによって、平滑用コンデンサＣ１を充電する。１次巻線ｎ１の電圧が出力平滑用コンデンサＣ２の電圧に達すると、出力整流ダイオードＤ３が導通し、変圧器Ｔ１の励磁エネルギーが出力へのエネルギー供給を始める。そして、１次巻線ｎ１の電圧は、出力平滑用コンデンサＣ２の電圧にクランプされるため、この時点以降は補償用インダクタンスＬ４と共振用コンデンサＣ３、Ｃ４と平滑コンデンサＣ１との自由振動が始まり、共振用コンデンサＣ３、Ｃ４の電圧がピークになると、流れる電流の向きが逆になり、Ｃ４→ｎ１→Ｌ４→Ｃ３→Ｄ２→Ｃ１→Ｄ１→Ｄ４の経路で電流が増加する。補償用インダクタンスＬ４に流れる電流がチョークコイルＬ１、Ｌ２に流れている電流と等しくなるまで上昇すると、ダイオードＤ１、Ｄ２がオフし、チョークコイルＬ１、Ｌ２を流れていた電流は、Ｌ１→Ｃ４→ｎ１→Ｌ４→Ｃ３→Ｌ２→ＲＣ１→Ｅｉの経路に流れる。この間チョークコイルＬ１、Ｌ２には共振用コンデンサＣ３、Ｃ４と平滑用コンデンサＣ１と交流入力電源Ｅｉと１次巻線ｎ１の電圧の和が印加され、チョークコイルＬ１、Ｌ２のエネルギーを再び増加させる。

【００３０】変圧器Ｔ１に残っていた励磁エネルギーがすべて２次側へ供給され、１次巻線ｎ１のクランプが解放されると、１次巻線ｎ１の電圧は急速に減少し、スイッチング素子Ｑ１、Ｑ２それぞれに印加される電圧は平滑用コンデンサＣ１の電圧に共振用コンデンサＣ３、Ｃ４の電圧を加えた値の１／２になる。以上の動作を繰り返してエネルギーの伝達を負荷側へ行う。この実施例の効果は前記第１の実施例と全く同様なので説明を省略する。なお、この実施例において、各スイッチング素子のいずれかの主端子と直列にダイオードを接続しても同じ効果が得られる。以上の第３，第４の実施例における補償用インダクタンス手段として，変圧器Ｔ１の漏れインダクタンスをその一部分，または全部として用いることも可能である。

【００３１】

【発明の効果】本発明は、以上述べたように高力率ＡＣ／ＤＣコンバータは簡素、小型軽量であって、軽負荷時に平滑用コンデンサＣ１の電圧を高く設定できることから高力率で動作する負荷範囲を広く設定でき、さらに負荷電流を考慮したエネルギーで平滑用コンデンサＣ１の充電を行うこともできるため、高力率で動作する負荷範囲をより広く設定できる。そして、このことは少なくとも２つのスイッチング素子で出力電圧の安定化制御を行うと同時に、交流入力電流の波形の改善ができ、力率は０．９８程度まで向上させることができる。また前置コンバータを設けた場合のような相互干渉は存在しない。さらにまたコンバータの共振作用により、スイッチング素子はゼロボルトスイッチングとなり、その共振用コンデンサはロスレススナバの役割を果たし、スイッチング素子のスナバ回路は不要となる。さらにコンバータの共振作用は変圧器のリセット回路の役割を果たしており、コンバータ変圧器はリセット巻線及び、リセットダイオードが不要となる。

【図面の簡単な説明】

【図１】本発明にかかる高力率ＡＣ／ＤＣコンバータの一実施例を示す図面である。

【図２】本発明の実施例における各部の電流，電圧波形を示す図面である。

【図３】本発明にかかる高力率ＡＣ／ＤＣコンバータの入力波形を説明するための図面である。

【図４】本発明と従来技術との特性を比較するための図である。

【図５】本発明にかかる高力率ＡＣ／ＤＣコンバータの第２の実施例を示す図である。

【図６】本発明にかかる高力率ＡＣ／ＤＣコンバータの第３の実施例を示す図である。

【図７】本発明にかかる高力率ＡＣ／ＤＣコンバータの第４の実施例を示す図である。

【図８】従来の高力率ＡＣ／ＤＣコンバータを示す図である。

【図９】従来の高力率ＡＣ／ＤＣコンバータの各部の電流，電圧波形を示す面である。

【図１０】従来の高力率ＡＣ／ＤＣコンバータの交流入力電流，電圧波形を示す図である。

【図１１】従来の高力率ＡＣ／ＤＣコンバータの交流入力電流，電圧波形を示す図である。

【符号の説明】

Ｅｉ・・・商用の交流入力電源、 ＲＣ１・・・全波整流回路

Ｌ１，Ｌ２・・・昇圧用のチョークコイル

Ｌ３・・・出力平滑用チョークコイル Ｌ４・・・補償用インダクタ

Ｃ１・・・平滑用コンデンサ Ｃ２・・・出力平滑用コンデンサ

Ｃ３，Ｃ４・・・共振用コンデンサ

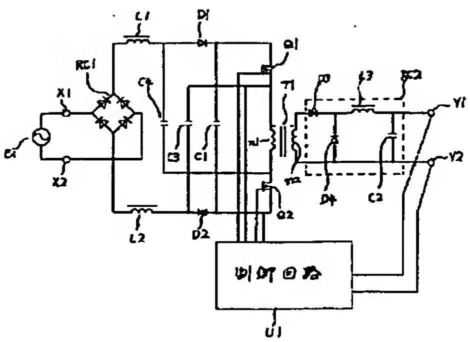
Ｔ１・・・変圧器 Ｕ１・・・制御回路

Ｑ１，Ｑ２・・・スイッチング素子

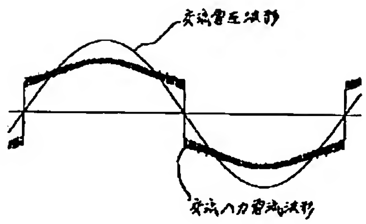
ＲＣ２・・・出力側整流・平滑回路

Ｄ３・・・フライ・ホイール・ダイオード

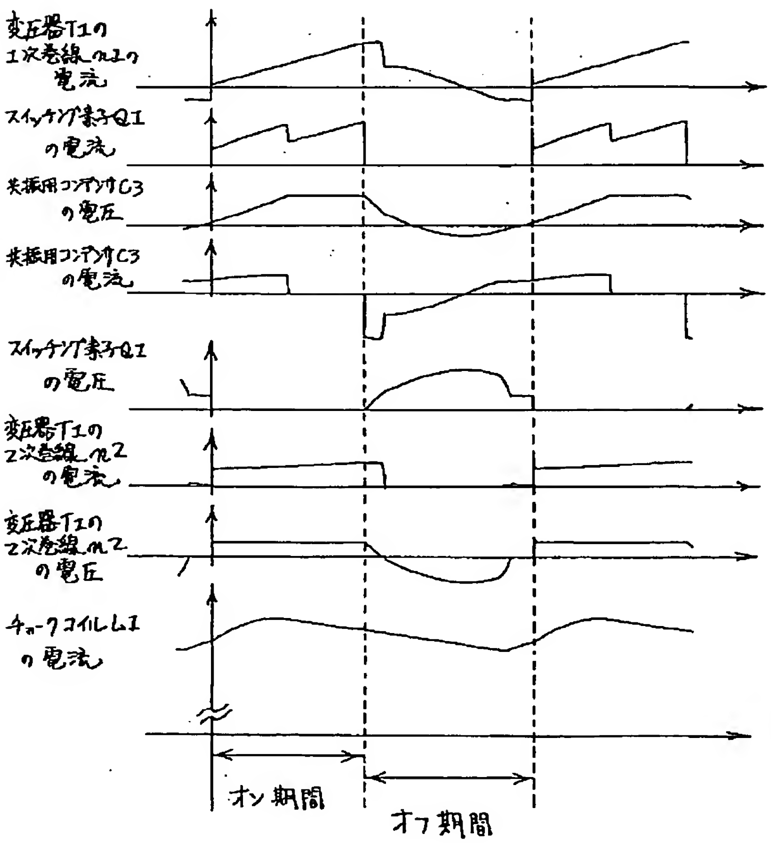
【図１】


制御回路

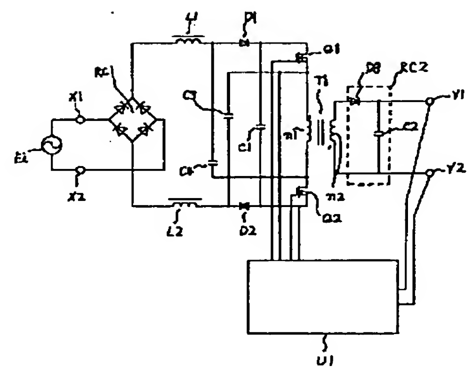
【図３】


交流電圧波形
交流入力電流波形

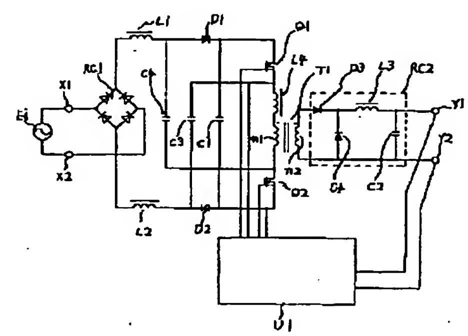
【図２】


変圧器T1の1次巻線n1の電流
スイッチング素子Q1の電流
共振用コンデンサC3の電圧
共振用コンデンサC3の電流
スイッチング素子Q1の電圧
変圧器T1の2次巻線n2の電流
変圧器T1の2次巻線n2の電圧
チョークコイルL1の電流
オン期間
オフ期間

【図５】



【図６】



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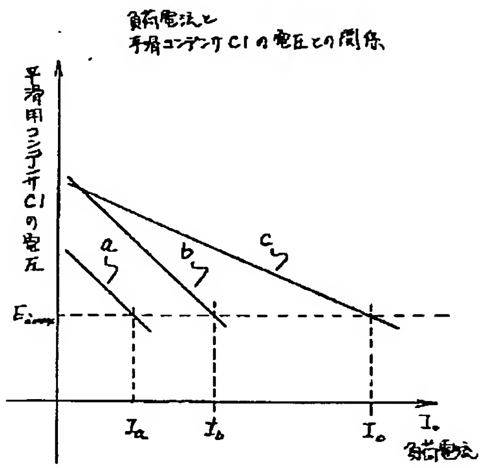

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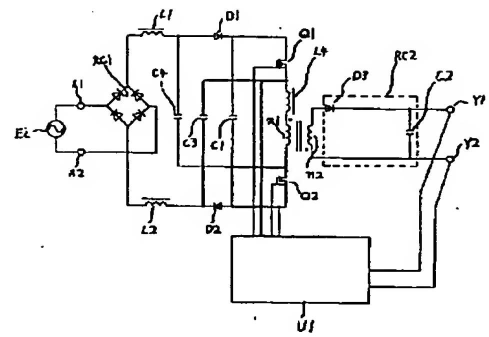

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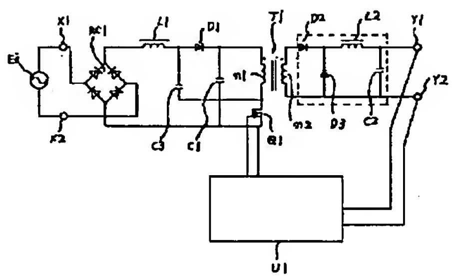

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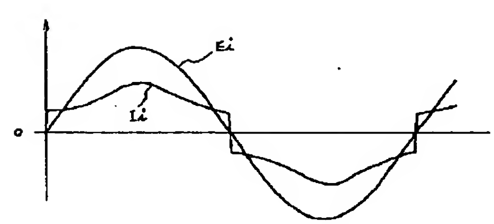

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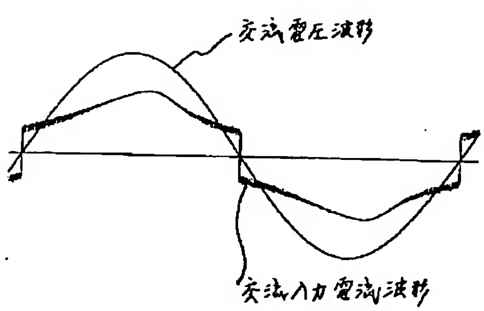

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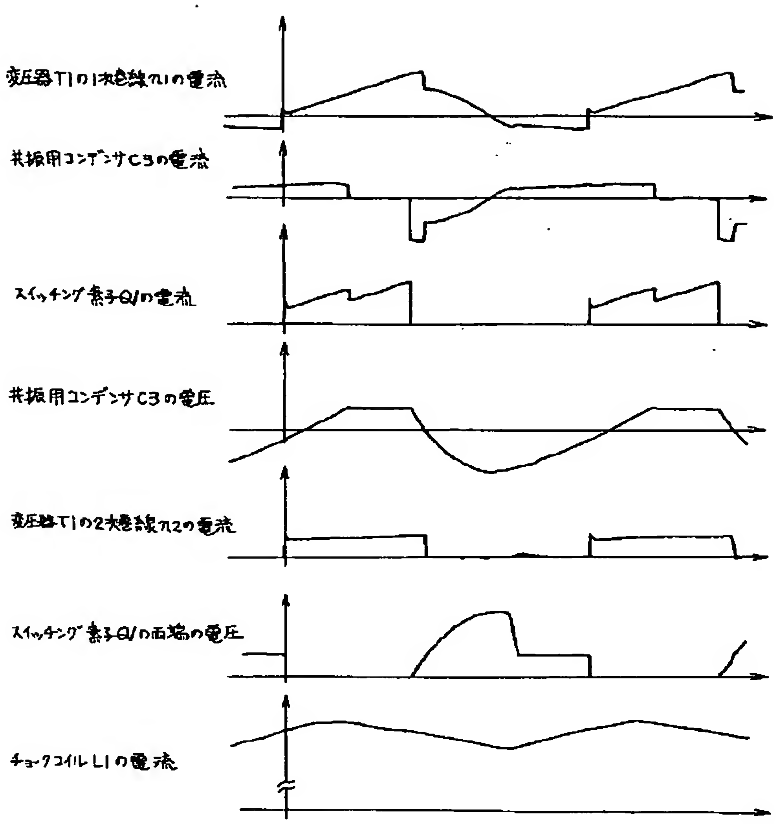

フロントページの続き

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1. This document has been translated by computer. So the translation may not reflect the original precisely.

2. **** shows the word which can not be translated.

3. In the drawings, any words are not translated.

CLAIMS

[Claim(s)]

[Claim 1] The rectifier circuit of the bridge type which connects with alternating current input power and rectifies alternating voltage, At least two choke coils which are connected to the direct-current output terminal of the rectifier circuit of this bridge type and by which the series connection was carried out, at least two diodes, and at least one capacitor for smooth, One main terminal is connected through at least one capacitor for resonance at each node of said choke coil and said diode. And at least two switching elements by which the main terminal of another side was connected to the end of said capacitor for smooth, In order to keep constant the output voltage of the transformer equipped with the primary coil and at least one secondary coil which were connected between said switching elements, the rectification means connected to said secondary coil, and said rectification means The rate AC/DC converter of high tensile which consists of a control circuit which performs on-off control of said switching element.

[Claim 2] The rate AC/DC converter of high tensile according to claim 1 by which the rectification means connected to the secondary coil of said transformer is characterized by transmitting energy to a load side corresponding to the time of ON of said switching element.

[Claim 3] The rate AC/DC converter of high tensile according to claim 1 by which the rectification means connected to the secondary coil of said transformer is characterized by transmitting energy to a load side corresponding to the time of OFF of said switching element.

[Claim 4] The rate AC/DC converter of high tensile according to claim 1 to 3 characterized by connecting diode to the primary coil of said transformer at a serial.

[Claim 5] The rate AC/DC converter of high tensile according to claim 1 to 4 characterized by forming a compensation inductance means in the primary coil of said transformer at a serial.

[Claim 6] The rate AC/DC converter of high tensile according to claim 1 to 5 characterized by constituting as said compensation inductance means using the leakage inductance of said transformer.

[Translation done.]

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Industrial Application] This invention relates to AC / DC converter of the rate of high tensile which changes a commercial alternating current input power electrical potential difference into stable direct-current output voltage.
[Description of the Prior Art] There are some which are shown in drawing 8 as the AC/DC converter which obtains direct current voltage in response to a commercial alternating current power source, especially an AC/DC converter of the easy rate of high tensile of a configuration. The full wave rectifier circuit where Ei was connected to commercial alternating current input power, and RC1 was connected to input terminals X1 and X2 in this drawing, L1 the capacitor for resonance, and D1 for a choke coil and C3 Diode, The transformer in which the capacitor for smooth and Q1 have a switching element, and, as for T1, C1 has the primary coil n 1 or secondary coil n2 of a turn ratio 1:1, As for D2, as for the diode for output rectification, and D3, fly wheel diode and L2 are the control circuits where the choke coil for output smooth and C2 were connected to the capacitor for output smooth, and U1 was connected to output terminals Y1 and Y2. A switching frequency is fully higher than a commercial alternating current frequency here, and to the switching frequency of a switching element Q1, the inductance of a choke coil L1 is fully large, and to the frequency of a commercial alternating

current, it is a sufficiently small value and let it be a sufficiently larger thing than the value of the excitation inductance of a transformer T1.

[0002] Actuation of this method is explained briefly. The wave of each part is shown in drawing 9 . Actuation shall be a steady state, the electrical potential difference of the capacitor C1 for smooth shall always be higher than the electrical potential difference of the alternating current input power Ei, and a switching frequency shall be immobilization. If a switching element Q1 turns on, the path of Ei->RC1 ->L1 ->C3 ->Q1 ->RC1 ->Ei will be made, and the current to which the energy which remained in the choke coil L1 with the energy which remained in the capacitor C3 for resonance just before a switching element Q1 turned on, and the energy of the alternating current input power Ei just before a switching element Q1 turned on is made to increase will flow.

[0003] If the increment in the energy of a choke coil L1 continues and the electrical potential difference of the capacitor C3 for resonance exceeds the electrical potential difference of the alternating current input power Ei until the electrical potential difference of the capacitor C3 for resonance reaches the electrical potential difference of the alternating current input power Ei, the energy of a choke coil L1 will begin reduction. And if the electrical potential difference of the capacitor C3 for resonance reaches the electrical potential difference of the capacitor C1 for smooth, the current which flows a choke coil L1 will be divided into the path of C3 ->Q1 ->RC1 ->Ei, the path of D1 ->C1 ->RC1 ->Ei, and the path of D1 ->n1 ->Q1 ->RC1 ->Ei, it will flow, and the energy of a choke coil L1 will continue reduction. On the other hand, among this "on" period, the capacitor C1 for smooth supplies energy to the secondary output until the electrical potential difference of the capacitor C3 for resonance reaches the electrical potential difference of the capacitor C1 for smooth, and after the electrical potential difference of the capacitor C3 for resonance reaches the electrical potential difference of the capacitor C1 for smooth, they are both a choke coil L1 and the capacitor C1 for smooth. It is [to which the electrical potential difference of the capacitor C1 for smooth rises at this time / being / or / or] dependent on the magnitude of the load current at this time, and an input current whether descent is carried out. Excitation energy is stored in a transformer T1 into this "on" period.

[0004] If a switching element Q1 is turned off next, the current which flows to a choke coil L1 will flow the path of D1 ->C1 ->RC1 ->Ei, and

will charge the capacitor C1 for smooth. And the energy of a choke coil L1 continues reduction. Moreover, the energy stored in the capacitor C3 for resonance discharges in the path of C3 ->D1 ->n1 ->C3, and it continues supplying energy to a secondary output until the fly foil diode D3 flows. At this time, the electrical potential difference impressed to a switching element Q1 rises gradually in connection with the energy of the capacitor C3 for resonance being emitted, and when the electrical potential difference of the capacitor C3 for resonance becomes zero, it reaches the electrical potential difference of the capacitor C1 for smooth. If the electrical potential difference of the capacitor C3 for resonance becomes zero, emission of the excitation energy of a transformer T1 starts, and as for the electrical potential difference of the capacitor C3 for resonance, a rise will be begun even in it at the reverse sense, the free vibration of the capacitor C3 for resonance and the excitation inductance of a transformer T1, i.e., resonance, will start, and the output rectifier diode D2 will change to a reverse bias condition. At this time, the electrical potential difference impressed to a switching element Q1 serves as a value which applied the reset electrical potential difference of a transformer T1 to the electrical potential difference of the capacitor C1 for smooth.

[0005] If emission of the excitation energy of a transformer T1 is completed and the electrical potential difference of the capacitor C3 for resonance becomes a peak, emission of the energy from the capacitor C3 for resonance starts, and the sense of the current which was flowing to the primary coil n1 increases conversely. if [it goes up until the current which flows to the primary coil n1 becomes equal to the current which is flowing to the choke coil L1] Flow [the current which was flowing the choke coil L1 / for the path of C3 ->n1 ->C1 ->RC1 ->Ei], the energy which the capacitor C3 for resonance has, and energy [which a choke coil L1 has], it begins [by diode D1 turning off] to charge the capacitor C1 for smooth. Since the inductance of a choke coil L1 has a value big enough compared with the excitation inductance of a transformer T1, the electrical potential difference which the variation of a current which flows to the primary coil n1 becomes small, and is generated also decreases quickly. At this time, the sum total of the electrical potential difference of the alternating current input power Ei, the electrical potential difference of the capacitor C3 for resonance, and the electrical potential difference of the capacitor C1 for smooth is impressed to a choke coil L1 and the primary coil n1, and the energy of a choke coil L1 begins an increment again. If the electrical potential difference generated in the primary coil n1 tends

to decrease to zero and a polarity tends to be reversed, in order that the current of the choke coil L2 for output smooth may carry out splitting to the output rectifier diode D2 and the fly foil diode D3, Mean short-circuiting the secondary coil n2 equivalent, and the electrical potential difference of the primary coil n1 is stopped by zero. Change of an exciting current is lost and the amount of [by the free vibration of a choke coil L1, and the capacitor C3 for resonance and the capacitor C1 for smooth] current change flows to each coil of a transformer T1 as splitting of the current of the choke coil L2 for output smooth. At this time, the electrical potential difference impressed to a switching element Q1 is stopped by the electrical potential difference of the capacitor C1 for smooth.

[0006] The above actuation is repeated and energy is transmitted. And although energy accumulated in a choke coil L1 into the ″on″ period of a switching element Q1 is enlarged relatively; since the energy of the capacitor C3 for resonance which did not finish discharging during the ″off″ period of a switching element Q1 near the zero of the electrical potential difference of the alternating current input power Ei is large, and the electrical-potential-difference difference of the alternating current input power Ei and the capacitor C1 for smooth is also large, the energy to emit also becomes large. On the other hand, near the peak of the electrical potential difference of the alternating current input power Ei, there is little energy of the capacitor C3 for resonance which did not finish discharging during the ″off″ period of a switching element Q1, and although energy accumulated in a choke coil L1 into the ″on″ period of a switching element Q1 is relatively made small, the electrical-potential-difference difference of the alternating current input power Ei and the capacitor C1 for smooth and the energy which a choke coil L1 emits since it is small become small. If the filter which removes a switching frequency component is prepared from this between the alternating current input power Ei and a full wave rectifier circuit RC 1, an input current as shown in drawing 10 will be obtained, and a power-factor will improve compared with the conventional thing.

[0007] While operating by the steady state, however, the excitation energy of a transformer T1 and the charge energy of a choke coil L1 and the capacitor C1 for smooth supplied from the alternating current input power Ei Although somewhat influenced by the electrical potential difference of the alternating current input power Ei, since it is hardly influenced by the load current, As the straight line a of drawing 4 R> 4 shows, it is the load current I0. In connection with increasing, the electrical potential difference of the capacitor C1 for smooth is the

maximum Ia of the load current corresponding to [descend on a big inclination and] the maximum Eimax of the electrical potential difference of the alternating current input power Ei. It will become a small value. Therefore, the load current will be restricted to the narrow range, and charge energy will become superfluous at the time of a light load, and the electrical potential difference of the capacitor C1 for smooth will rise greatly. Therefore, the design which narrowed the load current range, using the components of high pressure-proofing must be carried out to a switching element Q1 or the capacitor C1 for smooth. Becoming an input current wave form as shown in drawing 11 R> 1, although actuation as a converter will be carried out, if the load current is taken across the load current range which carried out the narrowed design, a power-factor declines. When the electrical potential difference of the capacitor C1 for smooth falls in connection with the load current increasing and this decreases from the maximum Eimax of the electrical potential difference of the alternating current input power Ei, it is to make the section when the electrical potential difference of the alternating current input power Ei exceeds the electrical potential difference of the capacitor C1 for smooth, and for a current to flow into the capacitor C1 for smooth regardless of turning on and off of a switching element Q1.

[0008]

[Problem(s) to be Solved by the Invention] This invention is simple circuitry and makes it a technical problem to obtain the small lightweight and economical rate AC/DC converter circuit of high tensile.
[Means for Solving the Problem] In order that this invention may solve this technical problem, alternating current input voltage is made rectification and smooth. Turn on and off this rectification electrical potential difference by the solid-state-switching component, and it is impressed by the primary coil of a transformer, obtain RF alternating voltage to a secondary coil, and this RF alternating voltage is set in rectification and the converter circuit which carries out smooth and obtained the predetermined electrical potential difference. Between an input rectifier circuit and the capacitor for input smooth, the choke coil for pressure ups and every at least two diodes are inserted. The rate AC/DC converter of high tensile characterized by connecting the capacitor for resonance, respectively between the node of each of this choke coil for pressure ups and diode and the node by the side of at least two transformers of a switching element is proposed.

[0009]

[Example] The fundamental part of this invention makes a switching

element plurality, and it is distributing the electrical potential difference impressed to a switching element, and a part for the power surge of the capacitor C1 for smooth at the time of a light load is compensated, it improves in a straight line b from the straight line a which shows the relation between the load current and the electrical potential difference of the capacitor C1 for smooth to drawing 4 , and it is characterized [main] by maintaining the rate of high tensile over the range of the large load current by this. Drawing 1 explains the rate AC/DC converter of high tensile concerning this invention. In drawing 1 , Ei(s) are commercial alternating current input power and a transformer in which the capacitor for smooth, and C3 and C4 have a capacitor for resonance, and, as for T1, diode and C1 have [X1 and X2] the primary coil n 1 or secondary coil n2 of a turn ratio 1:1 in an input terminal, the choke coil for [RC /1] pressure ups in a full wave rectifier circuit, and L1 and L2, and D1 and D2. Moreover, for D3, as for fly wheel diode and L3, the diode for output rectification and D4 are [the choke coil for output smooth and C2] the capacitors for output smooth, and these constitute output side rectification and a smoothing circuit RC 2. Switching elements Q1 and Q2 consist of a switching semiconductor device like FET, and a control circuit U1 carries out the on-off drive of the switching elements Q1 and Q2 on a frequency higher enough than a commercial alternating current frequency.
[0010] Here, the inductance of choke coils L1 and L2 serves as a value big enough to the switching frequency of switching elements Q1 and Q2, and to the frequency of a commercial alternating current, it is a sufficiently small value and let it be a sufficiently larger thing than the value of the excitation inductance of T1. Actuation shall be a steady state, its electrical potential difference of the capacitor C1 for smooth shall always be higher than the electrical potential difference of the alternating current input power Ei, and a switching frequency shall be immobilization. The current of each part at this time and a voltage waveform are shown in drawing 2 . If switching elements Q1 and Q2 turn on, the path of Ei->RC1 ->L1 ->C4 ->Q2 ->C1 ->Q1.->C3 ->L2 ->RC1 ->Ei will be made. With the energy which remained in the capacitors C3 and C4 for resonance just before switching elements Q1 and Q2 turned on, the energy of the capacitor C1 for smooth, and the energy of the alternating current input power Ei The current to which the energy which remained in choke coils L1 and L2 just before switching elements Q1 and Q2 turned on is made to increase flows.
[0011] If the increment in the energy of choke coils L1 and L2 continues and this electrical potential difference is exceeded until the sum of

the electrical potential difference of the capacitors C3 and C4 for resonance reaches the sum of the electrical potential difference of the capacitor C1 for smooth, and the electrical potential difference of the alternating current input power Ei, the energy of choke coils L1 and L2 will begin reduction. the capacitors C3 and C4 for resonance -- the current which flows choke coils L1 and L2 by diodes D1 and D2 flowing, if each electrical potential difference reaches the electrical potential difference of the capacitor C1 for smooth The path of L1 ->C4 ->Q2 ->D2 ->L2 ->RC1 ->Ei, and the path of L1 ->D1 ->C1 ->D2 ->L2 ->RC1 ->Ei, It is divided into the path of L1 ->D1 ->Q1 ->C3 ->L2 ->RC1 ->Ei, and the path of L1 ->D1 ->Q1 ->n1 ->Q2 ->D2 ->L2 ->RC1 ->Ei, and flows, and the energy of choke coils L1 and L2 continues reduction.

[0012] On the other hand, among this "on" period, the capacitor C1 for smooth supplies energy to the secondary output until the sum of the electrical potential difference of the capacitors C3 and C4 for resonance reaches the sum of the electrical potential difference of the capacitor C1 for smooth, and the alternating current input power Ei, and after reaching that electrical potential difference, they are both choke coils L1, L2, and C1. It is [to which the electrical potential difference of the capacitor C1 for smooth rises at this time / being / or / or] dependent on the magnitude of the load current at this time, and an input current whether descent is carried out. Excitation energy is conserved by T1 into this "on" period. If switching elements Q1 and Q2 are turned off next, the current which flows to choke coils L1 and L2 will flow the path of L1 ->D1 ->C1 ->D2 ->L2 ->RC1 ->Ei, and will charge the capacitor C1 for smooth. And the energy of choke coils L1 and L2 continues reduction. Moreover, the energy stored in the capacitors C3 and C4 for resonance continues supplying energy to a secondary output until it discharges in the path of C3 ->n1 ->C4 ->D1 ->C1 ->D2 ->C3 and the sum of the electrical potential difference of the capacitors C3 and C4 for resonance falls to the electrical potential difference of the capacitor C1 for smooth. At this time, the electrical potential difference impressed to each of switching elements Q1 and Q2 rises gradually in connection with the energy of the capacitors C3 and C4 for resonance being emitted, and when the sum of the electrical potential difference of the capacitors C3 and C4 for resonance reaches the electrical potential difference of the capacitor C1 for smooth, it reaches one half of the electrical potential differences of the electrical potential difference of the capacitor C1 for smooth.

[0013] If the sum of the electrical potential difference of the capacitors C3 and C4 for resonance reaches the electrical potential

difference of the capacitor C1 for smooth, the electrical potential difference of the primary coil n1 of a transformer T1 will fall to zero, and supply of the energy to a secondary output will stop. Emission of the excitation energy of a transformer T1 begins from this time. Emission of the excitation energy of a transformer T1 is performed as free vibration of the path of n1 ->C4 ->D1 ->C1 ->D2 ->C3 ->n1, and the capacitor C1 for smooth is charged with the energy and the excitation energy of a transformer T1 which remain in the capacitors C3 and C4 for resonance. After the electrical potential difference of the capacitors C3 and C4 for resonance reaches zero, the capacitors C3 and C4 for resonance and the capacitor C1 for smooth are charged with the excitation energy of the remaining transformer T1. this time -- switching elements Q1 and Q2 -- it is alike, respectively, and the electrical potential difference impressed is set to one half of the values which applied the electrical potential difference of the capacitors C3 and C4 for resonance to the electrical potential difference of the capacitor C1 for smooth, and switching elements Q1 and Q2 share almost equally the electrical potential difference of the capacitor C1 for smooth every [2 / 1/].

[0014] If emission of the excitation energy of a transformer T1 is completed and the electrical potential difference of the capacitors C3 and C4 for resonance becomes a peak, the energy-emitting from the capacitors C3 and C4 for resonance will start, the sense of the current which was flowing to the primary coil n1 will increase to the reverse sense, and the electrical potential difference generated in the primary coil n1 will begin a fall. If it goes up until the current which flows to the primary coil n1 becomes equal to the current which is flowing to choke coils L1 and L2, the current which diodes D1 and D2 turned off and was flowing choke coils L1 and L2 will flow for the path of L1 ->C4 ->n1 ->C3 ->L2 ->RC1 ->Ei. Since the inductance of choke coils L1 and L2 is a sufficiently big value compared with the excitation inductance of a transformer T1, the variation of a current which flows the primary coil n1 is very small, therefore the electrical potential difference generated in the primary coil n1 decreases quickly, and becomes zero mostly. If the electrical potential difference generated in the primary coil n1 decreases to zero, the current of the choke coil L3 for output smooth will shunt toward the output rectifier diode D3 and the fly wheel diode D4, and the amount of [by the free vibration of choke coils L1 and L2 and the capacitors C3 and C4 for resonance] current change will flow to each coil of a transformer T1 as splitting of the current of the choke coil L3 for output smooth. this time -- switching elements Q1 and

Q2 -- it is alike, respectively and the electrical potential difference impressed is stopped by one half of the electrical potential differences of the capacitor C1 for smooth.

[0015] the electrical potential difference of the capacitors C3 and C4 for resonance and the electrical potential difference of the alternating current input power Ei are impressed to choke coils L1 and L2, and the energy of choke coils L1 and L2 is made to increase in this condition -- it begins. The above actuation is repeated and energy is transmitted. And although energy accumulated in choke coils L1 and L2 into the "on" period of switching elements Q1 and Q2 is enlarged relatively, since the energy of the capacitors C3 and C4 for resonance which did not finish discharging during the "off" period of switching elements Q1 and Q2 near the zero of the electrical potential difference of the alternating current input power Ei is large, and the electrical-potential-difference difference of the alternating current input power Ei and the capacitor C1 for smooth is also large, the energy to emit also becomes large. On the other hand, near the peak of the electrical potential difference of the alternating current input power Ei, there is little energy of the capacitors C3 and C4 for resonance which did not finish discharging during the "off" period of switching elements Q1 and Q2, and although energy accumulated in choke coils L1 and L2 into the "on" period of switching elements Q1 and Q2 is relatively made small, the electrical-potential-difference difference of the alternating current input power Ei and the capacitor C1 for smooth and the energy emitted since it is small become small. The current which flows to choke coils L1 and L2 turns into a very small input current of distortion as shown in drawing 3 from this, and a power-factor improves. Furthermore, since the electrical potential difference impressed to each switching element by having set the switching element to two is reduced, the electrical potential difference of the capacitor C1 for smooth can be set up more highly than before, and the load range which operates at the rate of high tensile can be set up widely.

[0016] The [2nd example] Drawing 5 explains the 2nd example of this invention below. Although this example is the same configuration as the example shown in drawing 1 , they are the point which becomes reversed polarity as difference in a configuration unlike the case where the connection polarity of a transformer T1 is drawing 1 , and the point which is the half wave rectifier circuit where output side rectification and a smoothing circuit RC 2 consist only of output rectifier diode D3 and an output smoothing capacitor C2. And it is in the place where converter actuation is transposed to a flyback mold from the so-called

forward mold as a difference in actuation by the difference in this configuration. About the point of obtaining the rate of high tensile made into the purpose of other this invention, and the point that the load current range which operates at the rate of high tensile can be set up widely, it is common. It explains to below, avoiding duplication. In the period of ON of switching elements Q1 and Q2, since it flows in the path as said 1st example with the same current by the side of primary, explanation is omitted. In this "on" period, in the reverse bias condition, there is diode D3, and it is turned off, and a current does not flow at a secondary. Therefore, to the primary coil n1, a current flows on the electrical potential difference of the capacitor C1 for smooth, and excitation energy is conserved. After conserving excitation energy on the electrical potential difference of the capacitor C1 for smooth and reaching the electrical potential difference until the sum of the electrical potential difference of the capacitors C3 and C4 for resonance reaches the sum of the electrical potential difference of the capacitor C1 for smooth, and the electrical potential difference of the alternating current input power Ei, excitation energy is supplied from choke coils L1 and L2 and the capacitor C1 for smooth. Since this "on" period is fluctuated according to the condition of a load, excitation energy is also proportional to this.

[0017] If switching elements Q1 and Q2 are turned off next, the current which flows to choke coils L1 and L2 will flow the path of L1 ->D1 ->C1 ->D2 ->L2 ->RC1 ->Ei, and will charge the capacitor C1 for smooth. And the energy of choke coils L1 and L2 continues reduction. Moreover, the energy stored in the capacitors C3 and C4 for resonance discharges in the path of C3 ->n1 ->C4 ->D1 ->C1 ->D2 ->C3, and the sum of the electrical potential difference of the capacitors C3 and C4 for resonance makes the excitation energy of a transformer T1 increase until it falls to the electrical potential difference of the capacitor C1 for smooth. At this time, the electrical potential difference impressed to each of switching elements Q1 and Q2 rises gradually in connection with the energy of the capacitors C3 and C4 for resonance being emitted, and when the sum of the electrical potential difference of the capacitors C3 and C4 for resonance reaches the electrical potential difference of the capacitor C1 for smooth, it reaches one half of the electrical potential differences of the electrical potential difference of the capacitor C1 for smooth. If the sum of the electrical potential difference of the capacitors C3 and C4 for resonance reaches the electrical potential difference of the capacitor C1 for smooth, the electrical potential difference of the primary coil n1 of a transformer T1 will fall to zero,

and emission of the excitation energy of a transformer T1 will begin from this time. Emission of the excitation energy of a transformer T1 starts as free vibration of the path of n1 ->C4 ->D1 ->C1 ->D2 ->C3 ->n1, and charges the capacitor C1 for smooth with the energy and the excitation energy of a transformer T1 which remain in the capacitors C3 and C4 for resonance.

[0018] If the electrical potential difference of the primary coil n1 reaches the electrical potential difference of the capacitor C2 for output smooth, the output rectifier diode D3 will flow and the excitation energy of a transformer T1 will begin the energy supply to an output. And the electrical potential difference of the primary coil n1 is clamped by the electrical potential difference of the capacitor C2 for output smooth, and all the excitation energy that remained in the transformer T1 is supplied to a secondary, and the free vibration of the capacitors C3 and C4 for resonance, the capacitor C1 for smooth, and the excitation inductance of a transformer T1 continues until the clamp of the primary coil n1 is released. this time -- switching elements Q1 and Q2 -- it is alike, respectively and the electrical potential difference impressed is set to one half of the values which applied the electrical potential difference of the capacitors C3 and C4 for resonance to the electrical potential difference of the capacitor C1 for smooth. If emission of the excitation energy of a transformer T1 finishes and the energy-emitting from the capacitors C3 and C4 for resonance starts If it goes up until the current which a current increases in the path of C4 ->n1 ->C3 ->D2 ->C1 ->D1 ->D4, and flows to the primary coil n1 becomes equal to the current which is flowing to choke coils L1 and L2 The current which diodes D1 and D2 turned off and was flowing choke coils L1 and L2 flows for the path of L1 ->C4 ->n1 ->C3 ->L2 ->RC1 ->Ei. Since the inductance of choke coils L1 and L2 is a sufficiently big value compared with the excitation inductance of a transformer T1, the variation of a current which flows the primary coil n1 is very small, and the electrical potential difference generated in the primary coil n1 decreases quickly, and becomes zero mostly. this time -- switching elements Q1 and Q2 -- it is alike, respectively and the electrical potential difference impressed is stopped by one half of the electrical potential differences of the capacitor C1 for smooth.

[0019] The electrical potential difference of the capacitors C3 and C4 for resonance and the electrical potential difference of the alternating current input power Ei are impressed to choke coils L1 and L2, and it is begun to make the energy of choke coils L1 and L2 increase in this condition. The above actuation is repeated and energy is transmitted.

Since the effectiveness of this example is completely the same as said 1st example, explanation is omitted. In addition, in this example, even if it forms diode in each switching element and a serial, the same effectiveness is acquired.

[0020] The [3rd example] Drawing 6 explains the 3rd example of invention below. Although this example is the same configuration as the example shown in drawing 1 , as difference in a configuration, it is the point of having formed the inductor L4 for compensation in the primary coil n1 of a transformer T1, and the serial as an inductance means for compensation. And it is the point which stores the excitation energy proportional to the load current in the inductance L4 for compensation, relays that energy by the capacitors C3 and C4 for resonance during a "off" period into the "on" period of switching elements Q1 and Q2, and is supplied to the capacitor C1 for smooth as a difference in actuation by the difference in this configuration. About the point of obtaining the rate of high tensile made into the purpose of other this invention, and the point that the load current range which operates at the rate of high tensile can be set up widely, are common. In this example A part for the power surge of the capacitor C1 for smooth at the time of a light load is compensated, and it improves in a straight line c from the straight line a which shows the relation between the load current and the electrical potential difference of the capacitor C1 for smooth to drawing 4 , and is characterized [main] by maintaining the rate of high tensile over the range of the larger load current by this. It explains avoiding duplication.

[0021] If switching elements Q1 and Q2 turn on, the path of Ei->RC1 ->L1 ->C4 ->Q2 ->C1 ->Q1 ->C3 ->L2 ->RC1 ->Ei will be made. With the energy which remained in the capacitors C3 and C4 for resonance just before switching elements Q1 and Q2 turned on, the energy of the capacitor C1 for smooth, and the energy of the alternating current input power Ei The current to which the energy which remained in choke coils L1 and L2 just before switching elements Q1 and Q2 turned on is made to increase flows. If the increment in the energy of choke coils L1 and L2 continues and this electrical potential difference is exceeded until the sum of the electrical potential difference of the capacitors C3 and C4 for resonance reaches the sum of the electrical potential difference of the capacitor C1 for smooth, and the electrical potential difference of the alternating current input power Ei, the energy of choke coils L1 and L2 will begin reduction.

[0022] the capacitors C3 and C4 for resonance -- the current which flows choke coils L1 and L2 by diodes D1 and D2 flowing, if each electrical

potential difference reaches the electrical potential difference of the capacitor C1 for smooth The path of L1 ->C4 ->Q2 ->D2 ->L2 ->RC1 ->Ei, and the path of L1 ->D1 ->C1 ->D2 ->L2 ->RC1 ->Ei, It is divided into the path of L1 ->D1 ->Q1 ->C3 ->L2 ->RC1 ->Ei, and the path of L1 ->D1 ->Q1 ->L4 ->n1 ->Q2 ->D2 ->L2 ->RC1 ->Ei, and flows, and the energy of choke coils L1 and L2 continues reduction. On the other hand, among this "on" period, the capacitor C1 for smooth supplies energy to the secondary output, and after reaching that electrical potential difference, they are both choke coils L1 and L2 and the capacitor C1 for smooth, until the sum of the electrical potential difference of the capacitors C3 and C4 for resonance reaches the sum of the electrical potential difference of the capacitor C1 for smooth, and the alternating current input power Ei. It is [to which the electrical potential difference of the capacitor C1 for smooth rises at this time / being / or / or] dependent on the magnitude of the load current at this time, and an input current whether descent is carried out. Excitation energy is stored in a transformer T1 into this "on" period, and the energy proportional to the load current is stored in the inductance L4 for compensation.

[0023] If switching elements Q1 and Q2 are turned off next, the current which flows to choke coils L1 and L2 will flow the path of L1 ->D1 ->C1 ->D2 ->L2 ->RC1 ->Ei, and will charge the capacitor C1 for smooth. And the energy of choke coils L1 and L2 continues reduction. Moreover, the energy stored in the capacitors C3 and C4 for resonance discharges in the path of C3 ->L4 ->n1 ->C4 ->D1 ->C1 ->D2 ->C3, and the sum of the electrical potential difference of the capacitors C3 and C4 for resonance continues supplying energy to a secondary output, and stores energy in the inductance L4 for compensation until it falls to the electrical potential difference of the capacitor C1 for smooth. At this time, the electrical potential difference impressed to each of switching elements Q1 and Q2 rises gradually in connection with the energy of the capacitors C3 and C4 for resonance being emitted, and when the sum of the electrical potential difference of the capacitors C3 and C4 for resonance reaches the electrical potential difference of the capacitor C1 for smooth, it reaches one half of the electrical potential differences of the electrical potential difference of the capacitor C1 for smooth.

[0024] If the sum of the electrical potential difference of the capacitors C3 and C4 for resonance reaches the electrical potential difference of the capacitor C1 for smooth, the primary coil n1 of a transformer T1 and the electrical potential difference of the inductance

L4 for compensation will fall to zero, and supply of the energy to a secondary output will stop. At this time, it becomes impossible to maintain the reverse bias condition of the fly wheel diode D4, and the current of the output smooth choke coil L3 shunts toward the diode D3 for output rectification, and the fly wheel diode D4. The secondary coil n2 of a transformer T1 is short-circuited equivalent, and the electrical potential difference of the primary coil n1 becomes zero. By emission of the energy of the inductance L4 for compensation Free vibration is begun between resonant capacitors C3 and C4, the capacitor C1 for smooth, and the inductance L4 for compensation, and the capacitor C1 for smooth is charged with the energy of the capacitors C3 and C4 for resonance, and the energy of the inductance L4 for compensation. If the current of the inductance L4 for compensation decreases to the magnitude of the exciting current of a transformer T1, emission of the excitation energy of a transformer T1 will start, and the capacitor C1 for smooth will be charged with the energy and the excitation energy of a transformer T1 which remain in the capacitors C3 and C4 for resonance. After the electrical potential difference of the capacitors C3 and C4 for resonance reaches zero, the capacitors C3 and C4 for resonance and the capacitor C1 for smooth are charged with the excitation energy of the remaining transformer T1. this time -- switching elements Q1 and Q2 -- it is alike, respectively and the electrical potential difference impressed is set to one half of the values which applied the electrical potential difference of the capacitors C3 and C4 for resonance to the electrical potential difference of the capacitor C1 for smooth.

[0025] If emission of the excitation energy of a transformer T1 is completed and the electrical potential difference of the capacitors C3 and C4 for resonance becomes a peak The energy-emitting from the capacitors C3 and C4 for resonance starts, and the sense of the current which was flowing to the primary coil n1 increases to the reverse sense. If the inductance L4 for compensation and the electrical potential difference generated in the primary coil n1 rise until the current which flows to the primary coil n1 which begins a fall becomes equal to the current which is flowing to choke coils L1 and L2 The current which diodes D1 and D2 turned off and was flowing choke coils L1 and L2 flows for the path of L1 ->C4 ->n1 ->L4 ->C3 ->L2 ->RC1 ->Ei. Since the inductance of choke coils L1 and L2 is a sufficiently big value compared with the inductance L4 for compensation, and the excitation inductance of a transformer T1, the flowing variation of a current is very small, and the inductance L4 for compensation and the electrical potential difference generated in the primary coil n1 decrease quickly, and

becomes zero mostly. If the electrical potential difference generated in the primary coil n1 decreases to zero, it will become impossible to maintain the reverse bias of the output rectifier diode D3, and the current of the choke coil L3 for output smooth will shunt toward the output rectifier diode D3 and the fly wheel diode D4. The amount of [by the free vibration of choke coils L1 and L2 and the capacitors C3 and C4 for resonance] current change flows to each coil of a transformer T1 as splitting of the current of the choke coil L3 for output smooth. this time -- switching elements Q1 and Q2 -- it is alike, respectively and the electrical potential difference impressed is stopped by one half of the electrical potential differences of the capacitor C1 for smooth.
[0026] the electrical potential difference of the capacitors C3 and C4 for resonance and the electrical potential difference of the alternating current input power Ei are impressed to choke coils L1 and L2, and the energy of choke coils L1 and L2 is made to increase in this condition -- it begins. The above actuation is repeated and energy is transmitted. Since the energy according to the load current can be added to the energy supplied to the capacitor C1 for smooth by having formed the inductance L4 for compensation, at the time of a light load, it prevents that an excessive electrical potential difference occurs to the capacitor C1 for smooth, and the range of the load current which operates at the rate of high tensile can be set up more widely. Since other effectiveness is the same as said 1st example almost, explanation is omitted.
[0027] The [4th example] Drawing 7 explains the 4th example of invention below. Although this example is the same configuration as the example shown in drawing 1 , they are the point which becomes reversed polarity as difference in a configuration unlike the case where the connection polarity of a point and a transformer T1 which has formed the inductance L4 for compensation in the primary coil n1 of a transformer T1 and the serial is drawing 1 , and the point which is the half wave rectifier circuit where output-side rectification and a smoothing circuit RC 2 consist only of output rectifier diode D3 and an output smoothing capacitor C2. And they are the point which stores the excitation energy proportional to the load current in the compensation inductance L4, relays that energy by the capacitors C3 and C4 for resonance during a "off" period, and is supplied into the "on" period of switching elements Q1 and Q2 as a difference in actuation by the difference in this configuration at the capacitor C1 for smooth, and the point that converter actuation is transposed to the flyback mold from the so-called forward mold. About the point of obtaining the rate of high tensile made

into the purpose of other this invention, and the point that the load current range which operates at the rate of high tensile can be set up widely, it is common. It explains avoiding duplication.

[0028] In the period of ON of switching elements Q1 and Q2, since it flows in the path as said 3rd example with the same current by the side of primary, explanation is omitted. In this ″on″ period, in the reverse bias condition, there is diode D3, and it is turned off, and a current does not flow at a secondary. Therefore, to the inductance L4 for compensation, and a coil n1, a current flows on the electrical potential difference of the capacitor C1 for smooth, and excitation energy is conserved. After conserving excitation energy on the electrical potential difference of the capacitor C1 for smooth and exceeding the electrical potential difference until the sum of the electrical potential difference of the capacitors C3 and C4 for resonance reaches the sum of the electrical potential difference of the capacitor C1 for smooth, and the electrical potential difference of the alternating current input power Ei, excitation energy is supplied from choke coils L1 and L2 and the capacitor C1 for smooth. If switching elements Q1 and Q2 are turned off next, the current which flows to choke coils L1 and L2 will flow the path of L1 ->D1 ->C1 ->D2 ->L2 ->RC1 ->Ei, and will charge the capacitor C1 for smooth. And the energy of choke coils L1 and L2 continues reduction. Moreover, the energy stored in the capacitors C3 and C4 for resonance discharges in the path of C3 ->L4 ->n1 ->C4 ->D1 ->C1 ->D2 ->C3, and the sum of the electrical potential difference of the capacitors C3 and C4 for resonance makes the excitation energy of the inductance L4 for compensation, and a transformer T1 increase until it falls to the electrical potential difference of the capacitor C1 for smooth. At this time, the electrical potential difference impressed to each of switching elements Q1 and Q2 rises gradually in connection with the energy of the capacitors C3 and C4 for resonance being emitted, and when the sum of the electrical potential difference of the capacitors C3 and C4 for resonance reaches the electrical potential difference of the capacitor C1 for smooth, it reaches one half of the electrical potential differences of the electrical potential difference of the capacitor C1 for smooth.

[0029] If the sum of the electrical potential difference of the capacitors C3 and C4 for resonance reaches the electrical potential difference of the capacitor C1 for smooth, the inductance L4 for compensation and the electrical potential difference of the primary coil n1 of a transformer T1 will fall to zero, and emission of excitation energy will begin from this time. Emission of the excitation energy of

the inductance L4 for compensation and a transformer T1 starts as free vibration of the path of n1 ->C4 ->D1 ->C1 ->D2 ->C3 ->n1, and charges the capacitor C1 for smooth with the energy and the excitation energy of a transformer T1 which remain in the capacitors C3 and C4 for resonance. If the electrical potential difference of the primary coil n1 reaches the electrical potential difference of the capacitor C2 for output smooth, the output rectifier diode D3 will flow and the excitation energy of a transformer T1 will begin the energy supply to an output. And since the electrical potential difference of the primary coil n1 is clamped by the electrical potential difference of the capacitor C2 for output smooth, After this time, if the free vibration of the inductance L4 for compensation, the capacitors C3 and C4 for resonance, and a smoothing capacitor C1 starts and the electrical potential difference of the capacitors C3 and C4 for resonance becomes a peak The sense of the flowing current becomes reverse and a current increases in the path of C4 ->n1 ->L4 ->C3 ->D2 ->C1 ->D1 ->D4. If it goes up until the current which flows to the inductance L4 for compensation becomes equal to the current which is flowing to choke coils L1 and L2, the current which diodes D1 and D2 turned off and was flowing choke coils L1 and L2 will flow for the path of L1 ->C4 ->n1 ->L4 ->C3 ->L2 ->RC1 ->Ei. The sum of the electrical potential difference of the capacitors C3 and C4 for resonance, the capacitor C1 for smooth, the alternating current input power Ei, and the primary coil n1 is impressed to choke coils L1 and L2 in the meantime, and the energy of choke coils L1 and L2 is made to increase again.

[0030] if all the excitation energy that remained in the transformer T1 is supplied to a secondary and the clamp of the primary coil n1 is released -- the electrical potential difference of the primary coil n1 -- rapid -- decreasing -- switching elements Q1 and Q2 -- it is alike, respectively and the electrical potential difference impressed is set to one half of the values which applied the electrical potential difference of the capacitors C3 and C4 for resonance to the electrical potential difference of the capacitor C1 for smooth. The above actuation is repeated and energy is transmitted to a load side. Since the effectiveness of this example is completely the same as said 1st example, explanation is omitted. In addition, in this example, even if it connects diode to one main terminal of each switching element, and a serial, the same effectiveness is acquired. The thing [supposing all and using part] is also possible in the leakage inductance of a transformer T1 as an inductance means for compensation in the above example [3rd and 4th].

[0031]
[Effect of the Invention] As this invention was described above, since the rate AC/DC converters of high tensile are simplicity and a small light weight and the electrical potential difference of the capacitor C1 for smooth can be highly set up at the time of a light load, the load range which operates at the rate of high tensile can be set up widely, and since the capacitor C1 for smooth can also be charged with the energy which took the load current into consideration further, the load range which operates at the rate of high tensile can be set up more widely. And while this performs stabilization control of output voltage by at least two switching elements, the wave-like improvement of an alternating current input current can be performed, and a power-factor can be raised to about 0.98. Moreover, a mutual intervention like [at the time of forming a front-end converter] does not exist. According to a resonance operation of a converter, a switching element serves as zero bolt switching, and the capacitor for resonance plays the role of a loss loess snubber, and becomes unnecessary [the snubber circuit of a switching element] further again. Furthermore the resonance operation of a converter has played the role of the reset circuit of a transformer, and a converter transformer becomes unnecessary [a reset winding and reset diode].

[Translation done.]

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] It is the drawing in which one example of the rate AC/DC converter of high tensile concerning this invention is shown.
[Drawing 2] It is the drawing in which the current of each part in the example of this invention and a voltage waveform are shown.

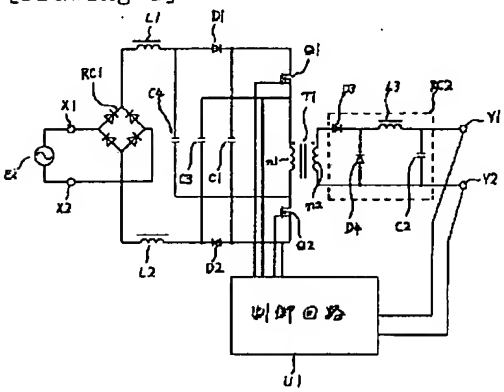
[Drawing 3] It is a drawing for explaining the input wave of rate AC of high tensile / DC converter concerning this invention.
[Drawing 4] It is drawing for comparing the property of this invention and the conventional technique.
[Drawing 5] It is drawing showing the 2nd example of the rate AC/DC converter of high tensile concerning this invention.
[Drawing 6] It is drawing showing the 3rd example of the rate AC/DC converter of high tensile concerning this invention.
[Drawing 7] It is drawing showing the 4th example of the rate AC/DC converter of high tensile concerning this invention.
[Drawing 8] It is drawing showing the conventional rate AC/DC converter of high tensile.
[Drawing 9] They are the current of each part of the conventional rate AC/DC converter of high tensile, and the field which shows a voltage waveform.
[Drawing 10] It is drawing showing the alternating current input current of the conventional rate AC of high tensile / DC converter, and a voltage waveform.
[Drawing 11] It is drawing showing the alternating current input current of the conventional rate AC of high tensile / DC converter, and a voltage waveform.
[Description of Notations]
Ei ... Commercial alternating current input power RC1 ... Full wave rectifier circuit
L1, L2 ... Choke coil for pressure ups
L3 ... Choke coil for output smooth L4 ... Inductor for compensation
C1 ... Capacitor for smooth C2 ... Capacitor for output smooth
C3, C4 ... Capacitor for resonance
T1 ... Transformer U1 ... Control circuit
Q1, Q2 ... Switching element
RC2 ... Output side rectification and smoothing circuit
D3 ... Fly wheel diode

[Translation done.]

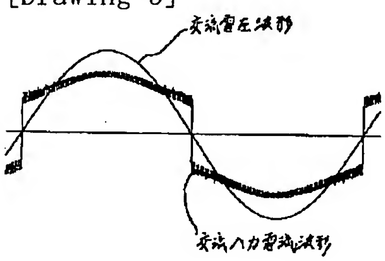
2. **** shows the word which can not be translated.
3. In the drawings, any words are not translated.

DRAWINGS

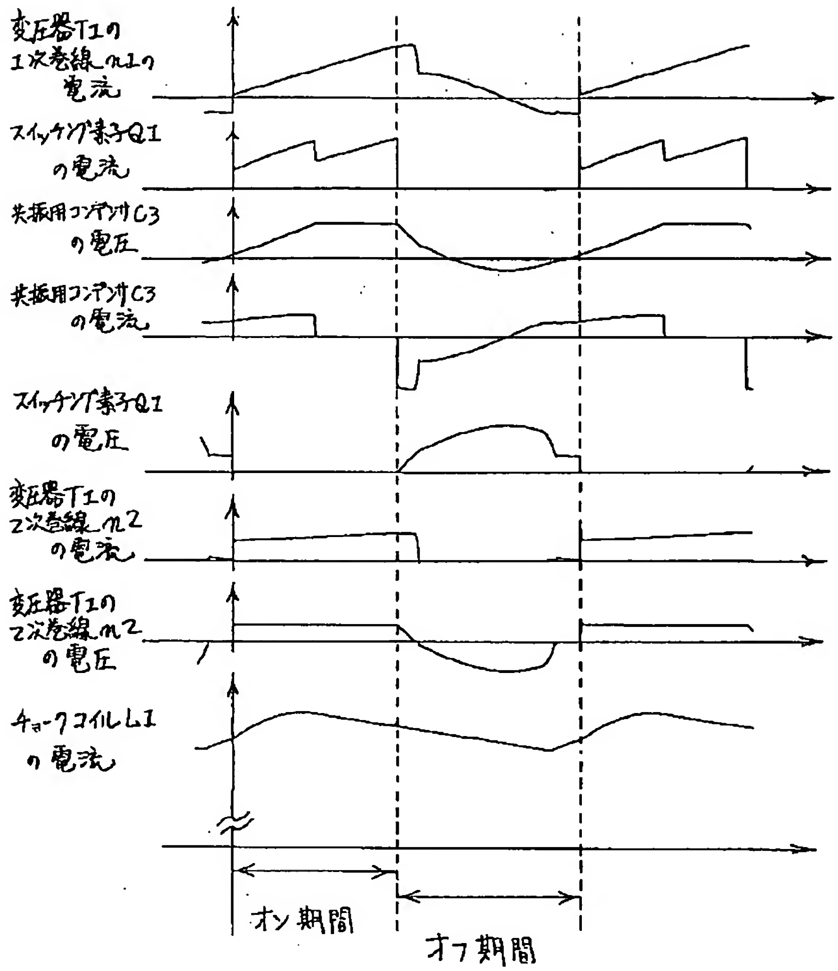
[Drawing 1]



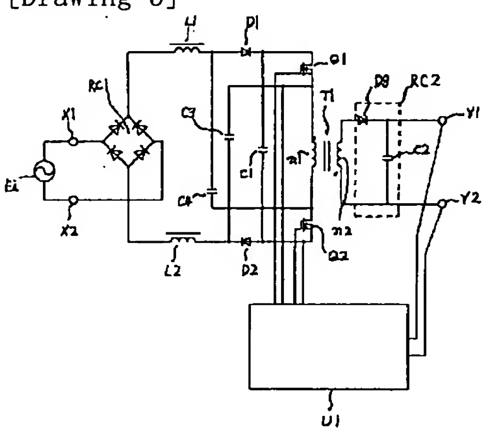
[Drawing 3]



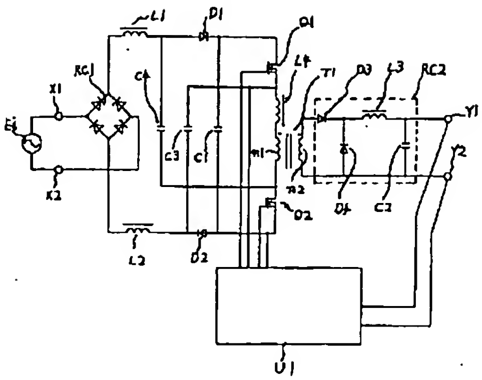
[Drawing 2]



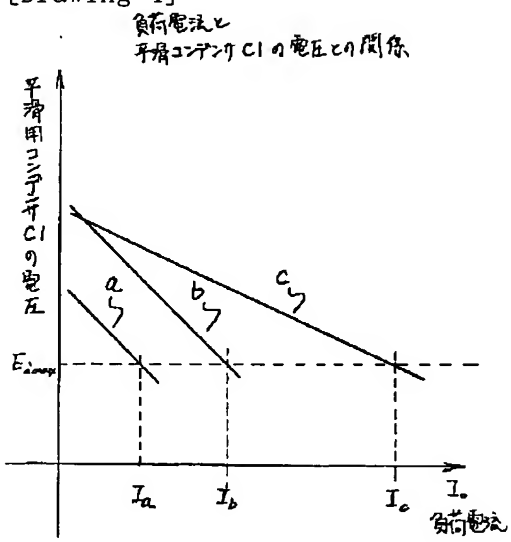
[Drawing 5]



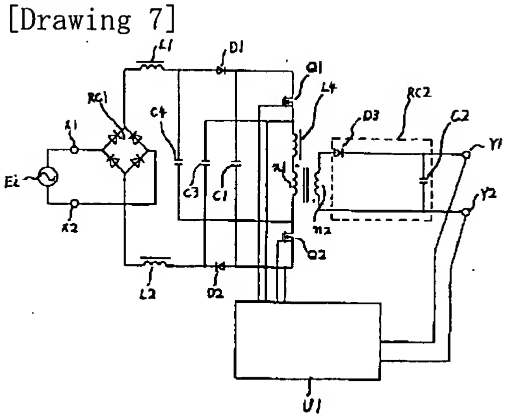
[Drawing 6]



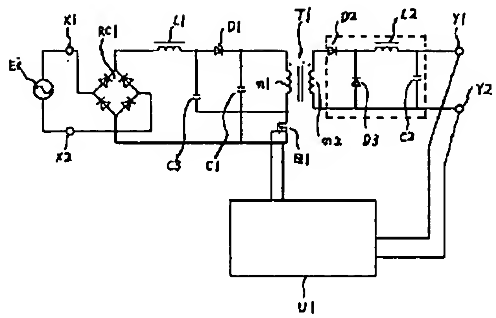
[Drawing 4]



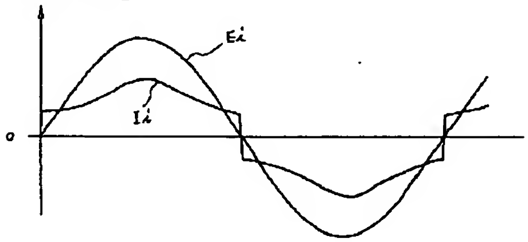
[Drawing 7]



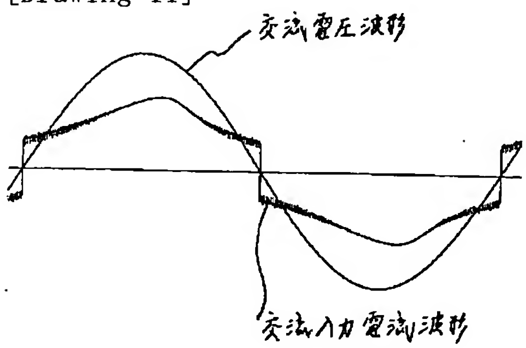
[Drawing 8]



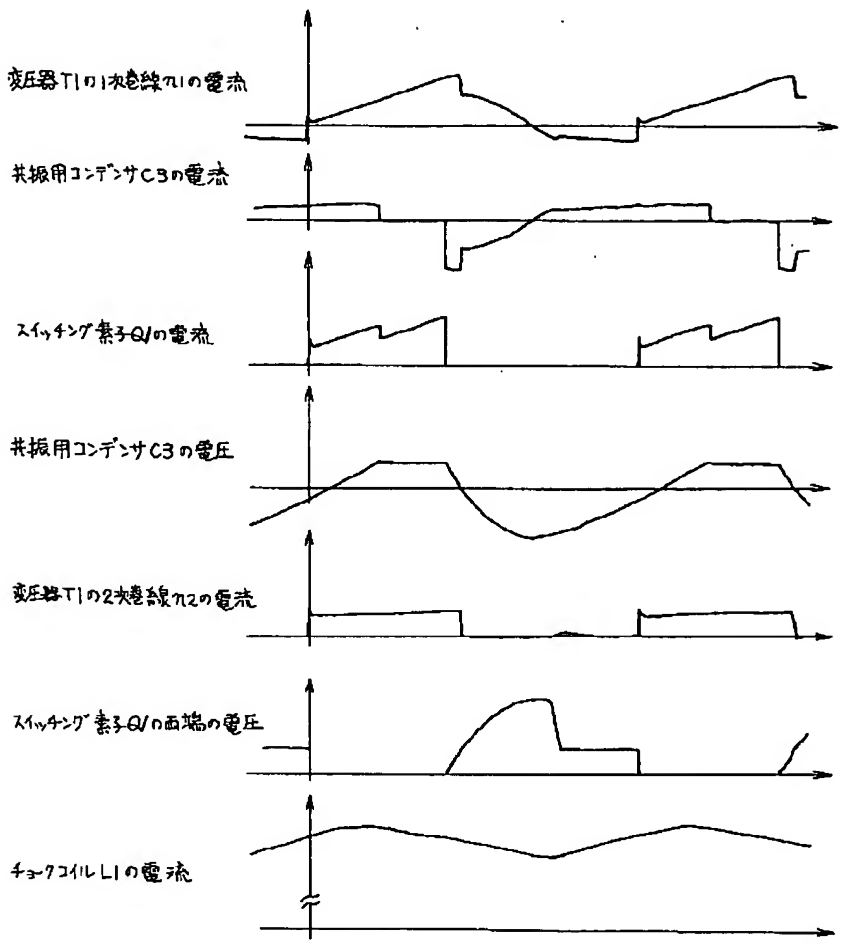
[Drawing 10]



[Drawing 11]



[Drawing 9]



[Translation done.]